U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-279 153

Manual for Evaluating Secondary Impacts of Wastewater Treatment Facilities

Abt Associates, Inc, Cambridge, Mass

Prepared for

Environmental Protection Agency, Washington, D C Office of Air, Land and Water Use

Feb 78

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/5-78-003	2.	3. RECIPIENT'S ACCESSION NO. PB279153
4. TITLE AND SUBTITLE Manual for Evaluating Secondary Impacts of Wastewater Treatment Facilities		5. REPORT DATE February 1978 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Malcolm S. FitzPatrick, Dean R. Ericson, John S. Willson, Dianne T. Wood, Gene Fax		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Abt Associates Inc. 55 Wheeler Street Cambridge, MA 02138		10. PROGRAM ELEMENT NO. 1HA095 11. CONTRACT/GRANT NO. 68-01-3268
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air, Land and Water Use 401 M Street, S.W. Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE EPA/600/16
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This manual describes procedures for assessing secondary impacts of wastewater treatment facilities. The manual guides the user through this impact assessment process by describing EPA policy and regulations governing analysis of these impacts; approaches to refine and improve existing projections of amount, type and location of projected growth in a service area; and the range of potential secondary impacts and alternative approaches for impact assessment. Application of projection and impact assessment approaches are provided for various levels of sophistication, consistent with analysis capabilities and available resources.

The manual also provides EPA Regional Reviewers with a convenient framework for evaluating quality of local analyses of secondary impacts and an analytic basis for imposing any needed special conditions.

This manual is a tool for planners and engineers preparing impact assessments; it does not supplant regulations which govern impact assessment processes. The manual considers only secondary impact assessment. Measures to mitigate these impacts have not been considered in the manual but should, of course, be implemented where the impact warrants.

Fourteen areas of secondary impacts are covered in the manual, categorized into four groups: Media Impacts (e.g., ambient noise levels); Sensitive Environmental Area Impacts (e.g., floodplains); Unique Area Impacts (e.g., parklands); and Secondary Economic Impacts (e.g., impacts on property values).

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Analytical Techniques Environmental Surveys Environment Land Use Urban Areas Assessments Water Resources Planning	Secondary Impact Assessment, Areawide Wastewater Planning, Analytical Techniques	14/A Methods and Equipment/ Cost Effectiveness

18. DISTRIBUTION STATEMENT UNLIMITED	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 186
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE A09, A01

EPA Form 2220-1 (9-73)

EPA-600/5-78-003
April 1977

MANUAL FOR EVALUATING SECONDARY IMPACTS OF WASTEWATER TREATMENT FACILITIES

by

Malcolm FitzPatrick
John Willson
Dean Ericson
Gene Fax
Dianne Wood

Contract No. 68-01-3268

Project Officer

Harry C. Torno
Office of Air, Land, and Water Use

Prepared for

OFFICE OF AIR, LAND, AND WATER USE
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

DISCLAIMER

This report has been reviewed by the Office of Air, Land, and Water Use, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

This manual describes procedures for assessing secondary impacts of wastewater treatment facilities. The manual guides the user through this impact assessment process by describing EPA policy and regulations governing analysis of these impacts; approaches to refine and improve existing projections of amount, type and location of projected growth in a service area; and the range of potential secondary impacts and alternative approaches for impact assessment. Application of projection and impact assessment approaches are provided for various levels of sophistication, consistent with analysis capabilities and available resources.

The manual also provides EPA Regional Reviewers with a convenient framework for evaluating quality of local analyses of secondary impacts and an analytic basis for imposing any needed special conditions.

This manual is a tool for planners and engineers preparing impact assessments; it does not supplant regulations which govern impact assessment processes. The manual considers only secondary impact assessment. Measures to mitigate these impacts have not been considered in the manual but should, of course, be implemented where the impact warrants.

Fourteen areas of secondary impacts are covered in the manual, categorized into four groups: Media Impacts (i.e., ambient noise levels); Sensitive Environmental Area Impacts (i.e., floodplains); Unique Area Impacts (i.e., parklands); and Secondary Economic Impacts (i.e., impacts on property values).

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

1.1 Objectives of the Manual 1

1.2 Definition of Secondary Impacts 2

1.3 EPA Policy on Secondary Impacts 3

1.4 Manual Organization and Use 4

2.0 INTRODUCTION 6

2.1 The Basic Issue: Sewers and Growth 6

2.1.1 Review of the Literature 6
2.1.2 The Geographic Context: Some Simplifying Assumptions 9

2.2 Use of Existing Population Forecasts 13

2.2.1 Problems with Small Area Forecasts 13
2.2.2 Selecting a Forecast 16

2.3 Projection of Future Growth 16

2.3.1 The Logic for Calculating Incremental Effects 16
2.3.2 First-Level Approach: A Checklist 18
2.3.3 Second-Level Approach 20
2.3.4 Third-Level Approach 23
2.3.5 Determination of Induced Growth 28

2.4 A Strategy for Guiding Secondary Impact Approach 30

3.0 MEDIA IMPACTS 33

3.1 Water Quality and Quantity 34

3.1.1 Increased Peak and Total Storm Runoff Volumes 34
3.1.2 First-Level Approach 36
3.1.3 Second-Level Approach 41
3.1.4 Third-Level Approach 44
3.1.5 Increased Sediment Yield 45
3.1.6 First-Level Approach 48
3.1.7 Second-Level Approach 48
3.1.8 Third-Level Approach 49
3.1.9 Increased Pollutant Loadings 49
3.1.10 First-Level Approach 50
3.1.11 Second-Level Approach 50
3.1.12 Third-Level Approach 52
3.1.13 Water Supply 52

3.2 Air Quality 56

3.2.1 Introduction 56
3.2.2 First-Level Approach 60
3.2.3 Second-Level Approach 60
3.2.4 Third-Level Approach 62

Page

3.3 Noise Impacts 63

3.3.1 Introduction to Community Noise 64
3.3.2 Converting Impact Measures to L_{dn} 72
3.3.3 First-Level Approach 75
3.3.4 Second-Level Approach 79
3.3.5 Third-Level Approach 85

3.4 Solid Waste Impacts 85

3.4.1 First/Second-Level Approach 90

4.0 SENSITIVE ENVIRONMENTAL AREAS 93

4.1 Wetlands 93

4.1.1 First/Second-Level Approach--Wetlands 96

4.2 Coastal Areas 97

4.2.1 First/Second-Level Approach--Coastal Area 102

4.3 Flood Plains 102

4.3.1 The Frequency of Flooding 103
4.3.2 Flood Disaster Protection Act of 1973 104
4.3.3 First/Second-Level Approach 107

4.4 Wildlife Habitats 108

4.4.1 First/Second-Level Approach--Wildlife Habitat 110

5.0 UNIQUE AREAS 114

5.1 Parkland 115

5.1.1 First-Level Approach--Parklands 115
5.1.2 Second-Level Approach--Parklands 118

5.2 Wild and Scenic Rivers 121

5.2.1 First-Level Approach--Wild and Scenic Rivers 122
5.2.2 Second-Level Approach--Wild and Scenic Rivers 124

5.3 Areas of Historic, Architectural, Archaeological, or Cultural Value 125

5.3.1 First-Level Approach 128
5.3.2 Second-Level Approach 131

6.0 SECONDARY IMPACTS ON AGRICULTURAL ENTERPRISE, ENERGY PRODUCTION AND CONSUMPTION, AND LAND VALUES 135

6.1 Impact on Agriculture 135

6.1.1 First-Level Approach--Agriculture 138
6.1.2 Second-Level Approach--Agriculture 140

Page

6.2 Impact on Demand for Energy 143

6.2.1 National Patterns of Energy Availability and Use 144

6.2.2 Sewer-Induced Land Use Change and Energy Use Patterns 146

6.2.3 First/Second-Level Assessment of Energy Impact 148

6.3 Impacts on Property Values 153

6.3.1 First/Second-Level Approach--Land Value Changes 154

References 157

Bibliography of Noncited Sources 169

LIST OF FIGURES

		Page
Figure 2.1	Interrelationship of Service Area, Growth Area and Economic Area	10
Figure 2.2	Interrelationship of Transportation Corridor and Subareas	12
Figure 2.3	Determination of Subarea Affected by Wastewater Treatment Facility	14
Figure 3.1	Interrelationships of Urbanization, Construction of Wastewater Treatment Facilities and Impact on Water	35
Figure 3.2	Values of Runoff Coefficient for Use With Rational Formula	38
Figure 3.3	Statistical Method for the Assessment of Runoff	43
Figure 3.4	Urban/Non-Urban Drainage Models	46
Figure 3.5	Annual Non-Point Pollutional Loads by Land Use Type	51
Figure 3.6	Graphs Showing Trends in Use of Water for Public Supplies, Rural Supplies, Irrigation, and Self-Supplied Industry. 1950-1970	53
Figure 3.7	National Primary and Secondary Ambient Air Quality Standards	57
Figure 3.8	Typical A-Weighted Sound Levels	66
Figure 3.9	Approximate Addition of Noise Levels	67
Figure 3.10	Design Noise Level/Land Use Relationships	68
Figure 3.11	Land Use Rating System Suggested by HUD	70
Figure 3.12	Yearly Average Equivalent Sound Levels Identified by EPA as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety	71
Figure 3.13	Correction Factor for Converting $L_{eq}(h)$ to L_{dn} For Highway Noise	73
Figure 3.14	Correction Factor for Converting $L_{eq}(24)$ to L_{dn} For Highway Noise	74
Figure 3.15	Correction Factor for Converting $L_{eq}(day)$ and $L_{eq}(night)$ to L_{dn} for Highway Noise	75

Page

Figure 3.16 Illustration of How to Construct Noise Border for First-Level Estimation of Aircraft Noise Impacts 77

Figure 3.17 Day-Night Equivalent Noise Level (L_{dn}) 84

Figure 3.18 Municipal Solid Wastes Collection Rates 86

Figure 3.19 Solid Waste Generation by Dwelling Type 86

Figure 3.20 Solid Waste Generation Rates by Dwelling Type 87

Figure 3.21 Estimates of Municipal Wastes 87

Figure 3.22 Baseline Estimates and Projection of Solid Waste Generation, Resource Recovery and Disposal, 1971 to 1990 88

Figure 3.23 Estimates of Manufacturing Wastes 89

Figure 6.1 Approximate Flow of Energy Through the United States Economy, 1971 145

Figure 6.2 Energy Consumption 147

Figure 6.3 Average Per Capita Energy Consumption by Alternative Development Patterns (In 10^6 Btu/Yr.) 151

Figure 6.4 Average Energy Consumption by Alternative Development (In 10^6 Btu/Yr.) 152

1.0 INTRODUCTION

Traditionally, it has been the practice, when constructing wastewater treatment and conveyance facilities, to consider only primary impacts (such as the impact of treatment plan discharges on the quality of receiving water) when assessing the environmental impacts of these facilities. The National Environmental Protection Act (NEPA) (1), guidelines of the Council on Environmental Quality, and recent federal regulations and policy development impose the additional requirement of assessing secondary or induced environmental impacts. This manual, a guide to assessing the secondary impacts of wastewater treatment facility (WWTF) construction, was developed for the U.S. Environmental Protection Agency (EPA) as a tool to aid in such assessment and to assist in better community decision-making.

This manual is intended to serve as an aid in the assessment of secondary impacts and not to supplant any regulations that govern the assessment of environmental impacts.

The manual considers only the assessment of secondary impacts and not their mitigation. It should be obvious that, before any plan is finalized or facility constructed, appropriate actions should be taken to mitigate any significant secondary impact.

1.1 Objectives of the Manual

This manual on secondary impacts of publicly owned wastewater treatment facilities (WWTFs) and associated collection systems is intended for two user groups:

(1) Local officials and their consultants responsible for identification and assessment of secondary impacts in preparing Step 1 facilities plans under EPA's Construction Grants Program; and

(2) EPA Regional staff and state officials responsible for environmental review of local Step 1 facilities plans and the subsequent decision whether to issue a negative declaration or call for preparation of an environmental impact statement.

For both of these user groups, this manual is designed to increase their understanding of:

- the range of potential secondary impacts of wastewater treatment facilities; and
- current EPA policy and regulations governing analysis of these secondary impacts.

Specifically, for local planners, the manual provides:

- a basis for refining and improving upon existing projections of economic and population growth;
- procedures to determine the amount, type, and location of the projected growth within the area to be directly served by the facility;
- step-by-step methodologies to identify and assess the full range of secondary impacts of WWTF construction; and
- a flexible approach to perform this analysis at varying levels of detail, depending upon local need, capabilities, and available time and resources.

The manual provides EPA Regional reviewers with:

- a convenient framework for judging the comprehensiveness and depth of local analyses of secondary impacts; and
- an analytic basis for imposing any needed special conditions upon localities as a part of the construction grants process.

1.2 Definition of Secondary Impacts

Final EPA regulations governing preparation of environmental impact statements defined secondary impacts of wastewater treatment facilities and other EPA construction activities as follows: (2)

> "Secondary impacts are indirect or induced changes. If the action involves construction of a facility, the secondary impacts would include the environmental impacts related to:
>
> (1) induced changes in the pattern of land use, population density and related effects on air and water quality or other natural resources
>
> (2) increased growth at a faster rate than planned for or above the total level planned by the existing community."

EPA Program Guidance Memo #50 (circulated to Regional Administrators in June 1975) has restated this definition in even briefer terms: (3)

> "Secondary effects of a project are indirect or induced changes in population and economic growth and land use, and other environmental effects resulting from these changes in land use, population, and economic growth."

These secondary impact definitions make clear the twofold nature of the secondary impact assessment task. First, local planners must be able to project future demographic, economic, and land use changes, with and without the wastewater treatment facilities. The difference between these two projections would represent the changes attributable to the proposed WWTF. Second, local planners must then be able to identify and assess the significance of environmental impacts resulting from these induced changes.

1.3 EPA Policy on Secondary Impacts

Current EPA policy and procedures for analysis of secondary impacts of wastewater treatment facilities are defined in Title 40, Part 6 of the Code of Federal Regulations (40 CFR 6) and Program Guidance Memo No. 50. (3) The Program Guidance Memo No. 50 states:

(1) Localities must identify and assess potential secondary impacts as an integral part of the Step 1 facilities planning process, using "best available data and analytical techniques."

(2) The critical determination is whether or not any potential secondary impacts will result in contravention of any existing federal, state or local environmental law or regulation, or any plan or standard required by such laws or regulations.

(3) Where secondary impacts resulting from a wastewater treatment facility "can reasonably be anticipated" to contravene an environmental law or regulation, plan or standard, the EPA Regional Administrator shall withhold approval of Step 2 or Step 3 construction grants until the local applicant either (a) revises the Step 1 facilities plan, (b) initiates steps to mitigate the adverse effects, or (c) agrees to special grant conditions requiring actions to minimize the effects. Furthermore, the locality must demonstrate "good faith" and be "clearly moving toward proper mitigative action" before a Step 2 grant is awarded.

(4) Any special grant conditions imposed by the EPA Regional Administrator must be "reasonable," and the local applicant must possess the requisite authority to fulfill the conditions.

(5) EPA follow-up of grantee compliance with any special conditions is required once the Step 2 grant is awarded. If an applicant fails to abide by grant agreement conditions, the Regional Administrator may take a number of actions, including:

-- withholding grant payments

-- refusing to process subsequent grant applications from the locality

-- refusing to approve grants for future phases of the same project

-- entering an injunction against the grantee

-- suspending all work on the project

-- terminating the grant and recovering unexpended EPA funds

1.4 Manual Organization and Use

The structure of this manual reflects the two parts of the assessment task: growth and land use projection and estimation of environmental impacts resulting from WWTF-induced growth.

Chapter 2 is designed to provide local planners with tools necessary to refine and improve upon existing population and land use projections, in order to determine the types, rate, and location of future growth in the WWTF service area, which is attributable to the facility. Three alternative and increasingly sophisticated approaches are suggested for projecting growth.

Chapters 3 through 6 in turn provide step-by-step methodologies for identifying and assessing secondary environmental impacts of this projected growth. Fourteen such secondary impacts are covered by the manual, categorized under four headings:

Chapter 3 -- Media Impacts

- surface water and groundwater quantity and quality
- ambient air quality
- ambient noise levels
- solid waste generation

Chapter 4 -- Sensitive Environmental Area Impacts

- wetlands
- floodplains
- coastal zone
- wildlife habitat

Chapter 5 -- Unique Area Impacts

- parklands
- wild and scenic rivers
- areas of historic, architectural, archaeological, or cultural value

Chapter 6 -- Secondary Economic Impacts

- agricultural land availability
- availability or demand for energy
- property values

Two or three approaches to secondary impact assessment are provided for each type of secondary impact. The approaches differ according to the analytical rigor with which the assessment is carried out. Alternatives are provided so that the user of the manual can apply an approach which is tailored to the potential seriousness of the individual impact, as well as the user's analytical capabilities and available resources.

Section 2.4 contains a procedure for conducting an initial assessment of the relative seriousness of these fourteen types of impact. The result of this preliminary "screening" is a prioritized list of impact types, which excludes impacts which are simply not expected to be present in the WWTF service area. The remaining impacts on this priority list are intended to be addressed sequentially beginning with the most serious, to which is applied the most sophisticated assessment alternative necessary.

The result of applying the procedures presented in this manual should be a statement of the type and magnitude of all secondary impacts which are expected to occur in a facility planning area due to the pattern and rate of growth induced by the facility.

2.0 INDUCED GROWTH RESULTING FROM WASTEWATER TREATMENT FACILITIES

This section provides the basic framework for projecting growth and land use changes, with and without the proposed waste treatment facility, so as to then determine the type, amount, and location of induced development in the area served by the proposed WWTF.

Section 2.1 summarizes the available technical literature on the relationship between sewer investments and urban growth patterns, and then defines a series of concepts useful for organizing the problem of sewer-induced growth. Section 2.2 provides the manual user with background information on the problems associated with using available substate population projections and general guidance on how to select the appropriate forecast for his particular locality. Section 2.3 supplies a series of three increasingly sophisticated procedures for projecting anticipated development without the proposed facility; it then discusses these same three procedures, this time assuming construction of the facility, and shows how induced growth is determined. Finally, Section 2.4 provides an initial "screening" method to help the local analyst identify which types of secondary environmental impacts are likely to present the most serious problems for his particular area, and thus a strategy for guiding the analysis in the most productive directions.

2.1 The Basic Issue: Sewers and Growth

2.1.1 Review of the Literature

Increased attention has been devoted recently to understanding what causes development to occur at particular locations, in a particular pattern, at particular points in time. Of special interest to planners are those growth stimulants which can be directly controlled by public policy, e.g., tax measures, land use and environmental regulations, and new public facility investments (4). While tax and regulatory policy may affect broad development patterns, the funding of new public facilities has a more immediate impact on specific land areas. As the Council on Environmental Quality noted in its Fifth Annual Report, "New sewers are becoming in many metropolitan areas the prime determinants of where and how fast new development occurs." (4) The CEQ underscored this point in its Sixth Annual Report, stating that "highways and sewers are especially significant growth stimulants." (5)

The most commonly recognized area of secondary impacts of sewers is new development. The location of new interceptors can significantly increase the number of "buildable" lots along their rights-of-way. A recent study of fifty-two federally funded interceptor sewer projects found that such lines tend to be oversized, in anticipation of future development based on inflated population projections which are at best "speculative" and filled with "great uncertainty." The oversizing itself contributes to the extent of the resulting development and "a circular and self-fulfilling process of growth occurs." (6) Regional interceptors also tend to run for long distances between existing towns and can encourage unwanted development of open space in the absence of effective development management. Combined with the tendency of developers to move immediately to the end of the new sewer line to take advantage of the available service where land prices are still relatively low, "the result is a costly leapfrog and fill-in development pattern, which increases the difficulty of properly planning the timing and sizing of other public facilities and spreads the urban area out in a pattern that is wasteful of land and energy resources." (4) From the standpoint of this manual on secondary impacts, the most important finding is that of the CEQ-funded study of interceptor sewer projects, namely that "on the local scale sewers actually induce growth that would not otherwise occur." (6)

To put the impact of sewer projects in perspective, it should be stressed that land use patterns are the result of a complex set of historical, economic, social and political interactions. "No single factor can be isolated as the cause of current land use practices...the role of interceptor sewers must, therefore, be seen as contributory rather than decisive." (6) Furthermore, lack of public sewer investments does not necessarily stop further development; if development pressures are intense, private sewerage systems can become financially feasible, e.g., individual septic tanks, package treatment plants. Thus, "development can continue unchecked without public investment in sewer facilities, but the form, intensity, and rate of development may be significantly altered." (7) Sewers, therefore, are neither a sufficient nor a necessary condition for development to take place. A recent EPA-sponsored study of secondary impacts reached a suitably guarded conclusion: "The limited empirical analysis available suggests that sewerage systems cannot always be isolated as instrumental causes of development. However, under a set of limited conditions not uncommon today, they may serve as a principal stimulus for localized development." (7)

The "limiting conditions" under which a new sewer investment will have important secondary effects are important to understand. Industrial location decisions depend primarily on access to labor and to external markets, with the influence of public sewer service usually being small. When, however, related urban highway investments in an area lead to lower land prices than central locations with equivalent access to labor and improved access to external markets, "a new sewer investment within the area will stimulate industrial development." (7) Commercial location is primarily sensitive to population distribution and access to households and, again, the relative influence of sewer service is probably small. The conditions under which a new sewer investment will likely have important secondary effects for commercial development are: "availability of vacant, previously unsewered land available at low cost, relative to average cost for comparable commercial sites, and having high access to households." (7) Of course, the secondary effects of sewers on residential development can in turn have an important lagged effect on the location of commercial activity. The principal link between housing location and sewer service is the density of residential development; sewers permit a more intense use of the land and therefore a larger return on the developer's land investment. The evidence from existing studies of the residential development process is mixed, pointing to, but not in all cases confirming, the key role of sewer investments in accounting for observed growth patterns. (8) These studies do, however, uniformly support the conclusion that lack of sewers can act as a constraint on development of all types. (7)

While the literature on the secondary impacts of sewers is far from unambiguous, the tack taken in this manual will be to assume, initially, that a proposed sewer project will serve as a stimulus to induce growth into the sewered area. This is an environmentally conservative approach, placing the burden on the local analyst to ask the appropriate questions and do the analysis required in order to substantiate, refute, or qualify the basic assumption according to local circumstances.

2.1.2 The Geographic Context: Some Simplifying Assumptions

An important task at the outset is to establish the bounds of the area within which secondary impacts will be analyzed.

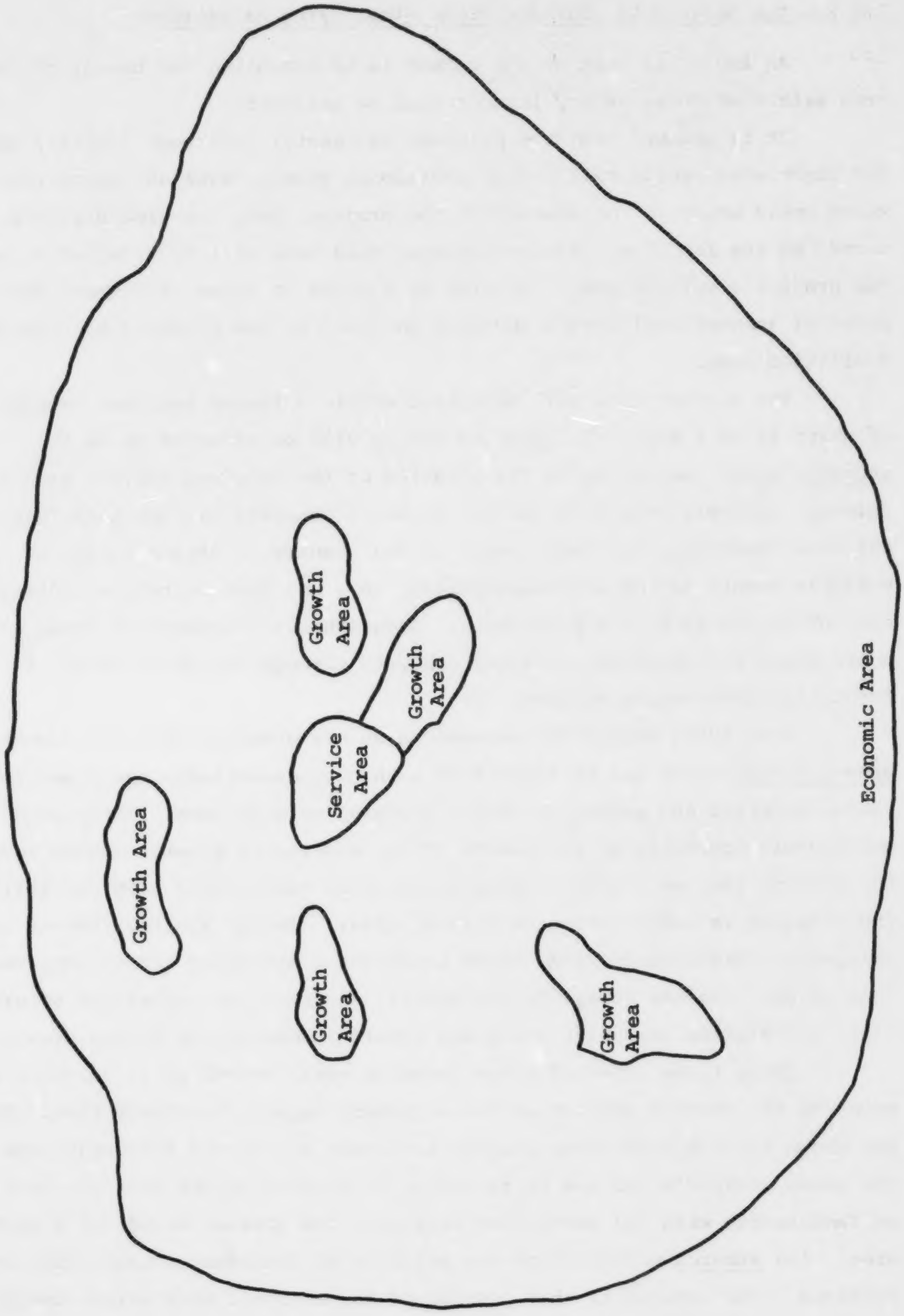
It is assumed that the proposed wastewater treatment facility through its associated sewers will induce additional growth, over and above that which would occur in the absence of the project, into the area directly served by the facility. For convenience this area will be referred to as the project's service area. It will be defined in terms of communities (or parts of communities) served and will be given by the proposed Section 201 facilities plan.

The service area will be nested within a larger regional economy of which it is a part. This larger entity will be referred to as the economic area. Depending on the location of the proposed service area the relevant economic area will include either a Standard Metropolitan Statistical Area (SMSA) or, for rural parts of the country, a single county or multiple county region tied economically to a non-SMSA center, typically a city of 25,000 to 50,000 population. Geographic definitions of these economic areas are available to local analysts through the OBERS Series E Population Projections Volumes. (9)

Also lying within the economic area are other potentially competing growth areas, which can be identified as having essentially the same growth characteristics and prospects as the proposed service area. These areas, which would logically be the source of any additional growth induced into the service area as a result of sewering, will most likely have the following features in common with the service area: similar availability of undeveloped but developable land, close to existing developed areas; comparable land prices; similar access to employment, shopping and recreation opportunities; and similar community attitudes toward accommodating future growth.

These three types of areas (service area, growth area, economic area) comprise the spatial context of the secondary impact assessment task. They are shown for a hypothetical project in Figure 2.1 on the following page. The local analyst's job now is to define, according to his best judgment based on familiarity with the particular locality, the spatial bounds of a fourth area: the subarea within which the analysis of secondary impacts will be confined. The subarea is that portion of the economic area which contains

FIGURE 2.1

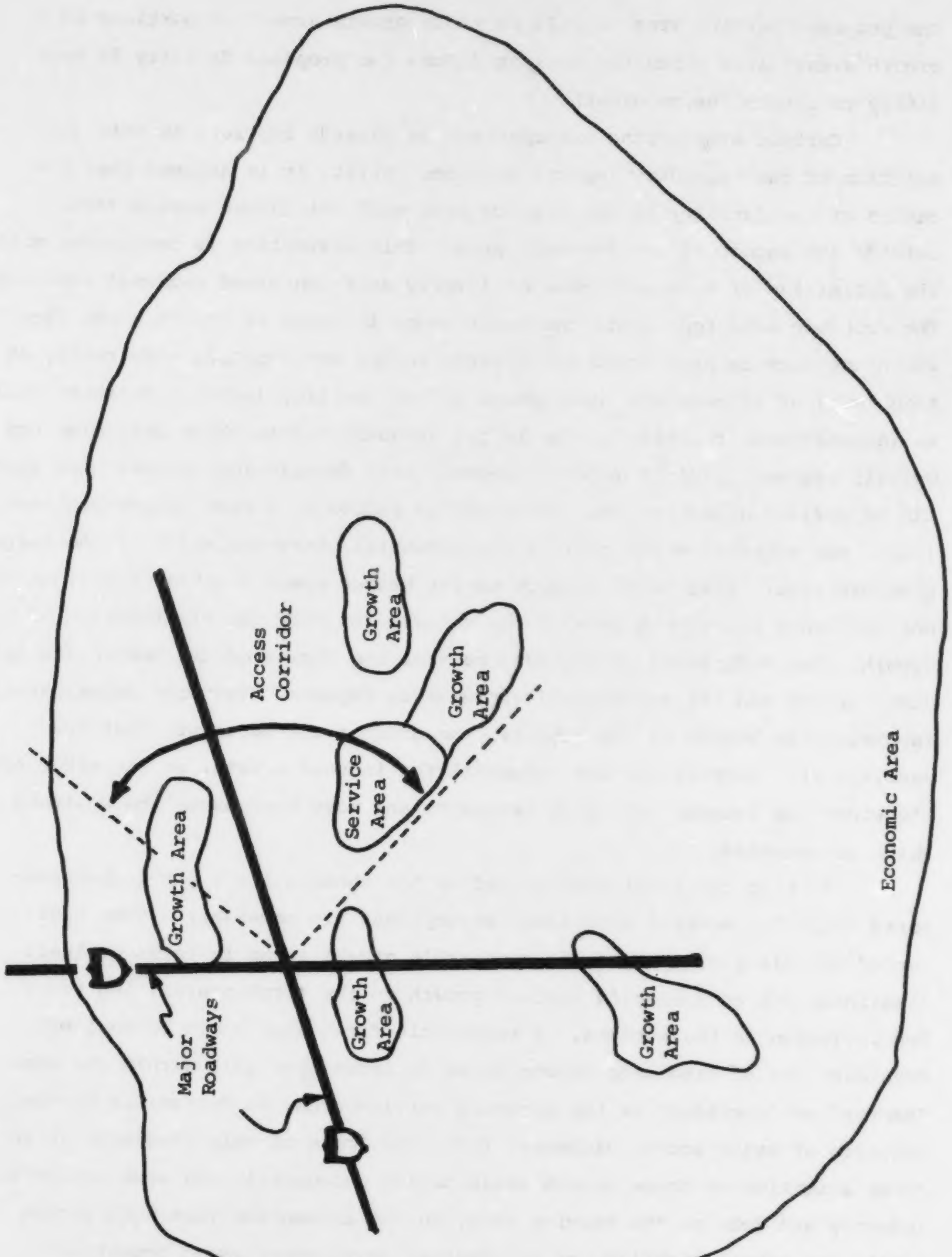

Growth Area
Growth Area
Service Area
Growth Area
Growth Area
Growth Area
Economic Area

the proposed service area as well as those growth areas (or portions of growth areas) from which the analyst judges the proposed facility is most likely to induce future growth.

Certain simplifying assumptions are already implicit in this formulation of the secondary impacts problem. First, it is assumed that location of the facility in the service area will not induce growth from outside the bounds of the economic area. This assumption is consistent with the definition of economic areas as largely self-contained regional economies. The economic area represents the outer bound in terms of growth areas from which the service area could conceivably induce development; conversely, at this level of aggregation the impacts of the facility location decision will be insignificant relative to the larger economic forces which determine the overall regional rate of growth. Second, this formulation assumes that there can be defined a smaller and, for analytic purposes, a more manageable area (i.e., the subarea) which retains the essential characteristics of the larger economic area: that, with respect to its bounds sewer location decisions do not influence the growth rate of the subarea but only the distribution of that growth. The definition of the subarea sets the limits of the search for induced growth and its secondary environmental impacts. The more geographically inclusive the bounds of the subarea, the greater the certainty that the analysis will capture all the potential for induced growth; on the other hand, the wider the subarea, the more extensive and more burdensome the analysis which is required.

To help the local analyst define the subarea for a particular proposed facility, several additional assumptions are necessary. Some basis is needed for discriminating among comparable growth areas in terms of their likelihood for contributing induced growth to the service area, and hence for inclusion in the subarea. A reasonable first step would be to limit consideration of candidate growth areas to those that fall within the same "sector" or "corridor" as the proposed service area, as determined by the location of major access highways. (10) The logic of this procedure is to focus attention on those growth areas having essentially the same access to industry and jobs as the service area, on the assumption that such access limits the substitutability of residential development among competing growth areas. (11) The effect of the procedure is to delimit the subarea to those growth areas closest to the service area. Such a transportation corridor is shown in Figure 2.2.

FIGURE 2.2


Economic Area
Access Corridor
Growth Area
Growth Area
Service Area
Growth Area
Growth Area
Growth Area
Major Roadways

Another assumption useful for defining a subarea which is manageable for analytic purposes is to arbitrarily draw the boundaries so that the subarea is compact, its constituent growth areas contiguous with the service area and each other. Again, mainly for practical reasons, the subarea should be drawn as that collection of whole political subdivisions (communities, townships, etc.) which most closely approximates the compact subarea. The results of this procedure are illustrated in Figure 2.3. While such a rendering of the subarea may violate reality slightly by including certain nongrowth areas as well, it more than compensates for this deficiency by the ease with which it can be presented and understood and the needed data assembled.

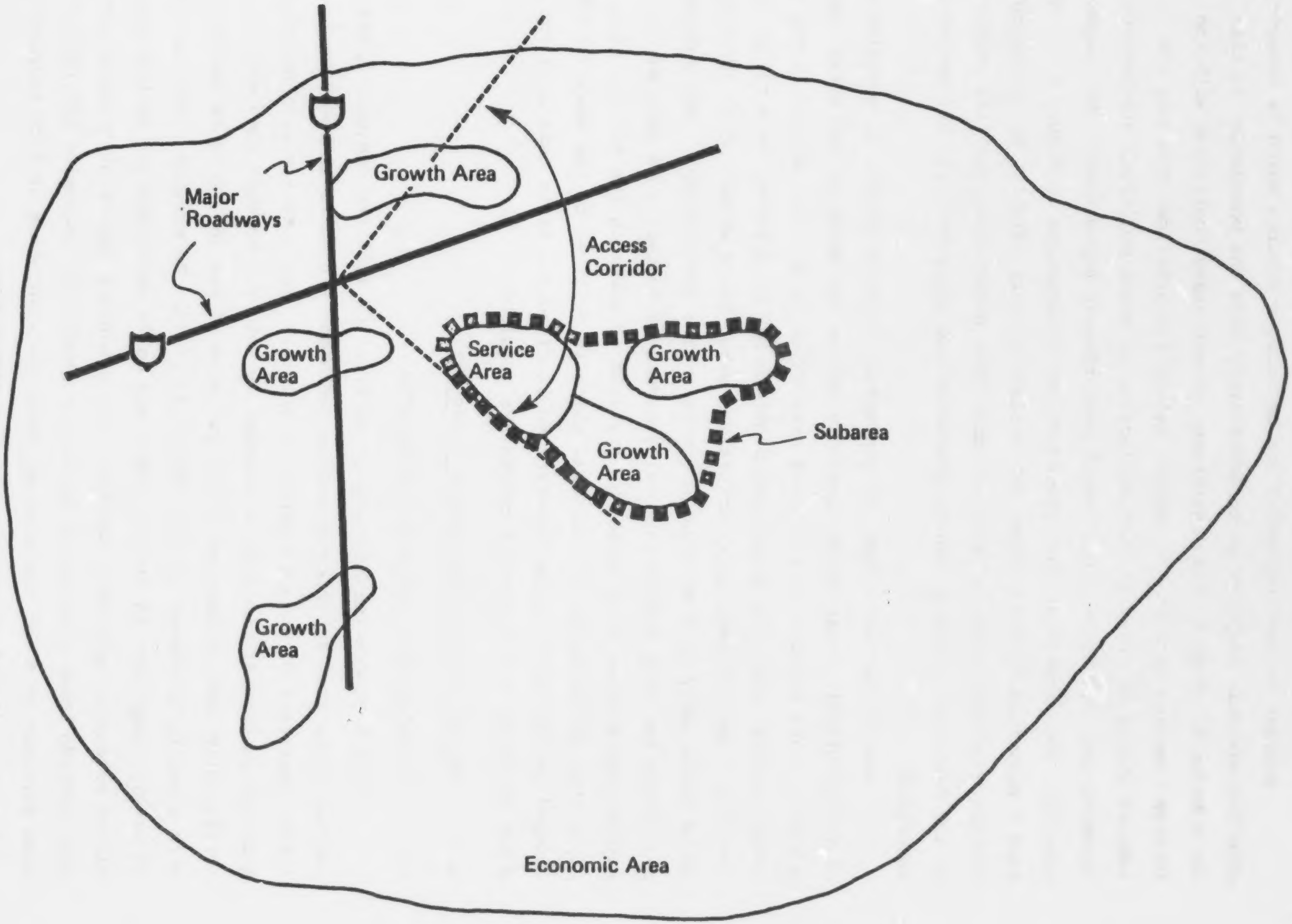
What we are left with, in conceptual terms at least, is a series of nested geographic areas which spatially define the scope of secondary impact analysis. The service area is that area which is directly served by the proposed facility and into which future growth may be diverted as a result of sewering. The economic area defines the outer bound within which sewering could conceivably lead to induced growth in the service area. The subarea represents the best available local judgment as to that area from which future growth might be diverted as a result of sewering the service area. It is this middle area, the subarea, which is critical to the analysis of induced growth and secondary environmental effects. It is this area for which projects of anticipated growth are required.

2.2 Use of Existing Population Forecasts

2.2.1 Problems With Small Area Forecasts

The 1974 CEQ-funded study of Section 201 facility projects cited earlier found that interceptor sizing decisions tended to be based on inflated forecasts of future population growth. "The question...is not whether such future populations will be reached or not, but whether they will be artificially induced because of the presence of new interceptors designed with capacity in excess of that required..." (6) Determining what capacity is really "required" is thus an important early consideration in the analysis of potential secondary impacts. The secondary impact assessment process affords local planners a useful opportunity to reexamine the population forecast used for the subarea, from the standpoint of data sources, projection methodology and key planning assumptions.

FIGURE 2.3


Growth Area
Major Roadways
Access Corridor
Growth Area
Service Area
Growth Area
Subarea
Growth Area
Growth Area
Economic Area

All population projection approaches share the characteristic that their forecast accuracy rapidly diminishes as the relevant time horizon lengthens; but small area projections must also deal with the added problem of human migration. Net migration is typically the component most responsible for small area population changes and the most difficult to project; projections of migration involve considerable uncertainty because of the absence both of suitable data and of an adequate theoretical foundation for projection. (12) Available subnational population forecast series handle migration differently. The U.S. Bureau of the Census projections estimate all components of population change, fertility and mortality as well as migration, using strictly demographic methods; a "component" method is used to estimate age-specific migration rates. In contrast, OBERS (Bureau of Economic Analysis, Economic Research Service) and National Planning Association migration techniques rest on assumptions about labor's responsiveness to projected economic change. (13) Because OBERS and NPA deal with migration from the viewpoint of the labor market, they should be able to be used to identify fluctuations and reversals in migration linked with changes in economic behavior, as compared to the more simple demographic assumptions of the Census based on historical trends.

A recent study of these three subnational series found, as expected, that they disagreed most frequently regarding migration. However, any supposed advantage of OBERS and NPA projections over those of the Census on this point was more than overshadowed by the tendency of all three series to grossly misrepresent 1973 expected population levels for a substantial majority of the states. More dramatic still, for 13 states at least one of the three series projected a 1980 population level that had already been exceeded in 1973. (13) The study concluded that "none is particularly adequate as a baseline forecast of practical use to state, regional or local planners, although each will certainly be put to use by these groups." (13) On balance, the study recommended local reliance on the standard cohort-component framework used by the Bureau of the Census over the OBERS and NPA series, on grounds that it is more easily adaptable to local needs and peculiarities.

The importance of local "judgmental" inputs as to distinctive local forces affecting population growth cannot be overemphasized. In appraising these local factors the analyst should take account of developments that may alter existing patterns of in- and out-migration or may place upper limits on further expansion of population. Among this first group are major industrial location decisions, sharp changes in unemployment, plans for large public facilities like universities and new transportation routes. Growth may be constructed by zoning, land capacity limits, availability of public services, etc.

2.2.2 Selecting a Forecast

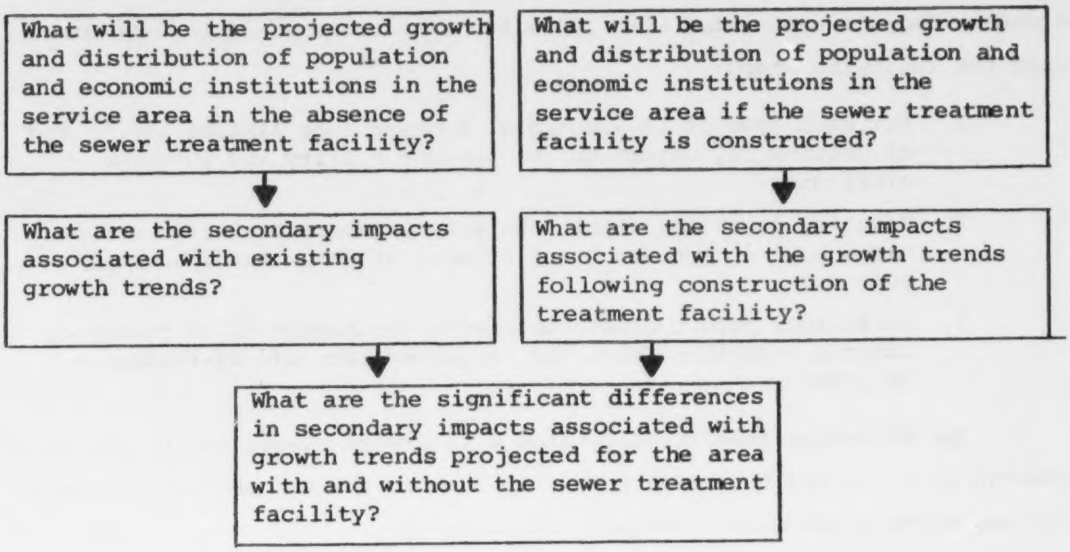
The utilization of an existing forecast as the basis to estimate subarea population growth should be subject to a number of evaluative criteria.

Projections of growth should be applicable to the subarea of concern. If the geographic scope of the projection area is larger than the subarea, the projection may not be useful simply because broader area characteristics may differ significantly from those prevailing in the subarea. If these differences can be identified, refinements in the forecast for application within the subarea can be made to reflect these differences. The forecast should be examined in terms of critical underlying assumptions, the quality of historical data upon which the forecasts are based, and the technical rigor with which forecast procedures were applied. The forecasted growth should cover a period of sufficient length for adequate assessment of secondary impacts; hence, a twenty-year time horizon is the minimum which should be considered before relying on an existing population projection result. Finally, the forecasting procedures used should be consistent with the nature of the forecasting problem; that is, the level of sophistication and the approach itself should be consistent with the need to determine sewer induced growth and secondary impacts at a subarea level, using the assumptions and definitions outlined in Section 2.1.2.

2.3 Projection for Future Growth

2.3.1 The Logic for Calculating Incremental Effects

It is essential to bear in mind that secondary impact assessment is concerned with incremental effects; that is, an area in which a sewer system is proposed would undoubtedly be subject to change even in the absence of the sewer system. Established patterns of growth (or decline) in the population and related institutions, as well as their spatial allocation, would continue; moreover, secondary impacts associated with these changes would develop and/or continue to be felt.


What will be the projected growth and distribution of population and economic institutions in the service area in the absence of the sewer treatment facility?
What will be the projected growth and distribution of population and economic institutions in the service area if the sewer treatment facility is constructed?
What are the secondary impacts associated with existing growth trends?
What are the secondary impacts associated with the growth trends following construction of the treatment facility?
What are the significant differences in secondary impacts associated with growth trends projected for the area with and without the sewer treatment facility?

Any approach to growth forecasting, either with or without the existance of a wastewater treatment facility, should encompass the following sequence of steps:

1. Collect and analyze data on local characteristics:
   - existing land use patterns,
   - availability of municipal services,
   - physical features,
   - natural resources, and
   - economic base.
2. Develop a forecast of population and employment growth over a twenty-year period.
3. Identify potential land use changes and locate probable growth within the area.
4. Identify local constraints which could affect growth and its location:
   - community attitudes,
   - unique factors (military base closing, sewer moratoria, etc.)
5. Finalize the estimate of growth and its location.

The above steps may be used to evaluate existing forecasts or to carry out a forecast.

Once it is determined how the population will grow and where it will locate, with and without the presence of treatment facilities, the secondary impacts associated with these two situations would be determined using the following steps:

1. For each type of environmental concern (see listing at the end of Section 2), determine its present quality and location attributes.
2. Identify locations within the subarea where projected growth might have an impact on one or more of these environmental concerns.
3. Where such points exist, determine the magnitude of secondary impacts associated with the projected rate and distribution of growth.

The secondary impacts associated with sewer-induced growth are then assessed by comparing the results of Step 3 above for the projected growth with and without the sewer treatment facility.

2.3.2 First-Level Approach: A Checklist

The objective of this first level approach is to provide the framework for developing an initial estimate of expected growth in order to determine if more detailed analysis is necessary.

The analyst should use best judgment, drawing on available secondary source data and opinions of local public and private sector representatives knowledgeable about economic development prospects to develop responses to the following questions:

1. What has been the annual population growth rate for the subarea? In any of the past five years has it equalled or exceeded .75% per annum? (Three quarters of one percent is approximately the average annual growth rate of the U.S.) (14) YES NO
2. Under any circumstance, does the expected population growth in the subarea over the next twenty years exceed 15% of the present population? (Fifteen percent is the result of multiplying .75% per year times 20 years.) YES NO
3. Area there any special characteristics of the subarea which indicate that development and/or expansion would lead to accelerated population growth? YES NO

4. Is there any reason to believe that industry growth (measured by number of employees) will exceed 1% per annum over the next twenty years? (One percent is the present average annual rate.) (15) YES NO

5. Are portions of the subarea expected to undergo significant changes in use? Is it likely that more than 15% of the land area will undergo change? (This assumes the same rate as in No. 2 above.) YES NO

If none of the participants in this exercise are able to provide a reasonably strong rationale for a "yes" or "no" response to any of these questions, the following data and analysis procedures should be utilized as appropriate to generate responses to these questions:

- Question #1 - Historical growth rate data may be available from the most recent local census, U.S. Series E. Census projections, building permits, school enrollment figures, telephone connections, etc.

- Question #2 - Estimates of future growth may be available from a number of state, regional, or local sources. At this level of analysis, one or more of these studies should be quickly accessed, without spending significant amounts of time on examining, evaluating, and comparing their methodological bases and/or rigor.

- Question #3 - Public natural resource management and recreation agencies should be checked to determine if there are any significant subarea characteristics which could contribute to major changes in subarea growth trends. In addition, representatives in public agencies involved in infrastructure development decisions (highways, dams, waterways, power-siting, and so forth) should be contacted to identify any major anticipated actions.

- Question #4 - Data are available from OBERS projections (Series E), Office of Business Economics (U.S. Department of Commerce), Business Statistics, and local, state, or regional industrial development authorities to assist in judging the rate of subarea industrial growth.

  U.S. Department of Commerce industrial growth projections for the region can be applied to present employment by industry to generate one measure of industrial growth.

  Other public agencies may have already done their own projections covering the subarea.

  A quick survey of major local industrial firms, and perhaps a sample of smaller businesses, could be used to determine if there are plans underway to expand operations within the subarea.

Finally, a simple linear extrapolation of historical trends in industrial growth can be used to assist in answering this question.

- Question #5 - A zoning map of the subarea defines the general pattern of current land uses. In conjunction with the data developed to answer the previous questions, particular portions of the subarea which are likely to be under considerable development pressure and are likely to be shifted from one use to another through major zoning changes should be identified. Discussions with planning board personnel, assessors, and other individuals in local (community, county, regional, or state) government should assist in determining if portions of the subarea are likely to witness significant changes in use.

If the participants respond in the affirmative to any one or more of these questions, the second level approach should be applied in order to develop a more rigorous estimate of population growth and distribution for the subarea.

If the responses to all of these questions are negative, the analyst should turn to Sections 2.3.5 and 2.4 of this chapter, where directions are provided for determining induced growth effects and giving initial consideration to the types of secondary impact which are likely to occur.

2.3.3 Second-Level Approach

The objective of the second-level approach is to refine initial judgmental findings by forecasting subarea land use patterns using estimated growth rates and anticipated distributions of population and industry. This approach follows closely the sequence of steps outlined in Section 2.3.2. It differs from the first-level approach mainly by relying less on local expert opinion and more on available secondary source data.

Step 1 - Collect and analyze data on local characteristics. The following attributes of the subarea should be identified and mapped through use of simple overlays:

- Vacant land: Local zoning maps encompassing the subarea should be examined in order to determine the number of acres of property within each type of zone (e.g., industrial, commercial, high-density residential, low-density residential, etc.) which are presently underutilized.
- The drainage characteristics of the land which could affect the ability of the property to support on-lot waste disposal, i.e., development dependent on septic systems.

- The physical features of the land (topographical profile, wetland and floodplain areas, etc.) which might limit more intensive use. Features ought to be differentiated according to whether they can be changed to allow for more intensive development or whether they are relatively inflexible in terms of alteration by man.
- The adequacy of water supply sources (ground and surface) to serve vacant and underdeveloped land in the community at higher densities.
- Existing land uses should be categorized, focusing on the types and density of residential, commercial, and industrial use which exist on property within the subarea.

The analyst should collect and evaluate this information in the simplest, most efficient manner possible, drawing on existing sources (i.e., SCS, USCS, State Departments of Transportation). The output of the analysis should be a clear understanding of the present distribution of land use activities within the subarea and attributes of the land which could influence the distribution of estimated growth for the subarea.

Step 2 - Develop a forecast of population growth over a twenty-year period. The use of OBERS Series E population data is a relatively simple option open for demographic projections. (9) Of particular interest to the local analyst is Volume III, where the data are aggregated by water resources regions and subareas. The units of aggregation in this volume include twenty major regions defined by hydrologic boundaries that are further divided into tributary and main-stem reaches entitled water resources subregions. The subregions cut across county lines to coincide with drainage patterns. However, the water resources subareas are actually county-defined approximations of the actual hydrologic units they represent. In some instances, the 208 areawide agency's planning area may closely approximate the water resource subarea boundaries, in which case their population projections can be utilized directly. One note of caution is in order, however. The assumptions made to arrive at the OBERS projections are explicitly stated in Volume I. If these assumptions represent significant violations of the prevailing conditions in the subarea, then extrapolations using different assumptions would be more appropriate.

It should also be noted that many states have their own programs that generate population and economic projections. Likewise, many universities engage in similar projection activities. It is conceivable that projections formulated from such sources would be more appropriate for some localities.

Step 3 - Identify potential land use changes and spatially locate probable growth within the service area. The population and industrial activity projections from Step 2 can be used along with existing zoning maps to estimate the extent of urban development that will occur over the twenty-year planning horizon. The allocation of anticipated population increases using graphic overlays of present zoning restrictions will provide the analyst with a picture of how the existing land use pattern might be expected to change over the twenty-year study period.

Step 4 - Identify local constraints which could affect growth and its location. While the forecasted growth rate and distribution of that growth is, up to this point, consistent with existing land use and zoning constraints, the analyst should now attempt to refine the forecast through consideration of a number of other critical factors which could influence the final, calculated figures. Thus, the planner should attempt to consider the effects of all of the following attributes on the forecasted population and industry figures:

- community attitudes - a community's attitude toward growth can determine the level of land use planning that occurs in an area, the nature of the community's response to development pressures, and extent of enforcement of growth controls. The local planner should, using the judgments of knowledgeable individuals, determine the likelihood of community attitudes strongly affecting the projected population and/or employment growth and distribution;
- development of significant energy resources located in the subarea;
- expansion (or cutback) of military facilities;
- location of new federal, state, or local facilities in the subarea;
- development moratoria in surrounding subareas which might be duplicated with the subarea under study;
- major transportation developments within the larger economic area which could strongly influence the subarea;
- presence of natural resources (water, recreation, wilderness, cultural and historical values) which are likely to become more important in the near future;
- changes in zoning to meet development pressures.

For each of these factors, the analyst should contact individuals who are intimately familiar with the subarea and its immediate surroundings in order to develop a soundly based judgment regarding the effect(s) of each of these attributes on the growth rate and distribution conclusions developed through the previous steps.

Step 5 - Finalize the estimate of growth and its location. In this final step, the local planner should take the estimates of growth and its distribution derived in Step 4 and cycle back through the previous steps to determine if the final estimates are consistent with the major conclusions drawn at each step; that is, considering the present uses of land and the various constraints on its future use, does the projected growth and distribution of population and industrial activity seem reasonable, given land availability as well as any special features of the land which could influence its future use and the attitudes of residents of the subarea?

2.3.4 Third-Level Approach

Projection of growth and allocation of population and industrial activity at this third level consists of a more rigorous approach to the land use change and allocation step (Step 3) of the second-level approach. (16) All other analysis steps are the same as in the second level approach.

At this level, spatial allocation of growth to determine land use changes involves four essential steps:

- identification and ranking of available parcels according to their relative attractiveness for development;
- allocation of industrial firms to individual parcels based upon rank;
- allocation of projected residential growth to individual parcels; and
- development of a projected land use map based upon the above allocations of future growth.

Allocation of commercial activity is not done as part of this approach, since this activity is sensitive to population distribution and access by households, and is therefore assumed to follow these distributions closely.

Step 1 - Identify and rank parcels of land. Allocations should be done sequentially for each type of land use--industrial, high-density, residential. medium- and finally, low-density residential. The analyst should use a subarea land use (and zoning) map and divide the entire subarea into small units (parcels) of about 10 acres each, noting the "available land" in each parcel. Available land is defined as that which can be more intensively developed, over and above its present use; that is, property having potential uses which can capture a "higher land rent," providing that other conditions (such as zoning) permit this.

Each parcel should be ranked according to its relative attractiveness for future development, depending on the use being allocated. (19,20) The following criteria of attractiveness for potential development, ranked in descending order of importance, should be used:

A. Is it zoned according to the intended use (industrial, residential--by density, commercial)?

B. Is it intended to be a part of a development unit (industrial park, large-scale development, planned unit development)?

C. Does it have high accessibility by roadway?

D. Does it have rail access?

E. Does it have public wastewater treatment available?

F. Does it have electric or gas available?

Each parcel should be ranked by judgmentally applying and summing these numbers for each parcel. This recommended method perhaps overemphasizes the criteria with the higher priorities. However, the method is simple and direct. (If one wishes to attach some other priority, based on experience, then the user may state the basis and proceed.)

It should be noted that included in the above criteria is the availability of wastewater treatment (E). The availability of wastewater treatment depends, of course, on whether the forecast and allocation of growth is being done with or without the construction of the sewer treatment facility which is the subject of this investigation.

As an example of how the process would work, assume that one is ranking lots in order to allocate industrial uses. A specific parcel of ten acres is undeveloped (forest) except for a two-acre parcel containing an old house. For industrial purposes, this parcel has 100% available land.

Criteria for Ranking Land

Criteria	Industrial	Residential		
		High	Medium	Low
A	6	6	6	6
B	5	5	5	5
C	4	4	3	3
D	3	N/A	N/A	N/A
E	2	4	4	4
F	1	2	2	2

Ranking value associated with criteria given in text.

Since it is not zoned industrial nor planned for an industrial park, no values are assigned under A or B. However, since it has good access, it is assigned a 4 under C, and a 1 under F; assume it has no sewer currently available (or planned) and is without access by rail. Therefore, the parcel has associated with it a rank value of 5 (C and F). This parcel would not be allocated an industrial use until all other available parcels in the subarea with rankings of 6 or higher had already been allocated.

Step 2 - Allocate projected industrial growth to individual parcels based upon industrial use ranking. To do this the analyst must project the number of industrial facilities likely to locate (or expand) in the subarea and their associated land requirements.

In order to project the number of facilities, the analyst must estimate expected industrial employment for the subarea, which in turn requires a reliable estimate of expected total employment. This section provides a simple procedure for making these determinations.

First, the analyst should calculate future total employment for the subarea. The suggested approach consists of multiplying the total population forecast (see Step 1 above) and multiplying it by a base year (1970, for instance) ratio of OBERS employment to population in the subarea:

$$\text{Employment forecast} = \text{population forecast} \times \frac{\text{1970 OBERS employment}}{\text{1970 OBERS population}}$$

This method does not attempt to adjust for differences between the boundaries of the subarea of interest and the OBERS area.

Having forecast total employment, the analyst should next identify that portion of the total which is industrial (manufacturing) employment. This is done by multiplying total employment forecast by the ratio of manufacturing to total earnings for the OBERS area:

$$\text{1990 manufacturing employment in subarea} = \text{1990 employment for subarea} \times \frac{\text{1990 OBERS mfg. earn.}}{\text{1990 OBERS total earn.}}$$

It should be emphasized that the OBERS figures should be "adjusted," as needed, to reflect the employment opportunities actually expected to be available in the subarea. (The reader is referred back to Section 2.2.1.)

Third, the planner must be able to translate the projected industrial employment into the number of firms which will actually locate or expand operations within the subarea. The size distribution of these firms, as measured by a number of employees, can also be generated at this point; its main use comes when spatial allocation decisions are made.

The results of the most recent Department of Commerce Industrial Location Survey can be useful to this task (18); however, these are national averages and should be used with caution in specific local situations. That survey established the following size distribution of firms seeking new locations:

17% will employ 75 persons
27% will employ 175 persons
41% will employ 325 persons
15% will employ 625 persons

Thus, for a typical 100 firms, the industrial employment would be 28,700 persons, or 287 persons per firm. The projected 1990 industrial employment figure obtained in the previous step can then be divided by 287 to yield an estimate of the total number of firms which would have to locate or expand to account for the expected industrial growth:

$$\text{No. of firms locating in subarea, 1990} = \frac{\text{1990 industrial employment in subarea}}{\text{287 workers/firm}}$$

To quickly estimate a size distribution, the planner should list the number of firms expected to locate in the subarea. The first 17% of the firms should be assigned 75 employees, the next 27% assigned 175 employees, and so forth. Although clearly there is no absolute relationship between a firm's employee size and its land consumption requirements, employee size can be used as a proxy to land needs in allocating individual firms to individual parcels.

Using the list of firms expected to locate in the subarea, select firms randomly from this list and allocate each to the central piece of land with the highest industrial use. If the available land on the parcel is not sufficient for the acreage needs of the firm, add adjacent parcels when possible. If this firm requires a site for which contiguous industrial use land is not sufficient, replace it, and select another firm at random. Proceed with this random selection and allocation until all the projected firms have been allocated to available land in order of their ranking as determined by relative attractiveness for industrial development.

Step 3 - Allocation of projected residential growth. High-density residential uses can pay the next highest land rent and therefore should be the next use to be allocated within the subarea. Before proceeding, the planner should rerank the remaining available parcels to reflect the new use to which the land is being allocated. For example, the percent of "available land" within a given parcel may be less due to the lower rent that high-density residential (compared to industrial) development can afford to pay. Furthermore, any remaining parcel whose ranking includes a value for rail access should be revalued because this factor generally has no weight for various residential uses.

High density residential uses should now be distributed among available parcels, according to their rank on descending order and consistent with limits on density imposed on each parcel either by natural conditions (soil type) or zoning requirements. If there are no natural or man-imposed limits on density development on a particular parcel, then the planner should assume that the future density will be no greater than

$$\text{Present highest density in the subarea} \times \frac{\text{20-year projected population in subarea}}{\text{current population in subarea}}$$

Projected future population is distributed to high-density residential use until all suitable parcels are allocated; then the remaining population is distributed to medium-density use in the same fashion, then low-density use, until all the remaining projected population is allocated. It is only the projected (i.e., 20-year) population that is being allocated; when this population has been exhausted, the procedure is stopped.

An example of this allocation process follows: Assume that the highest ranking parcel (10 acres) for high-density land use is zoned for 40 units per acre. At an average of 4 persons per unit, and with 50% of the parcel "available" land, 800 persons will be located on this parcel. If the projected population which has to be allocated is 41,500, then 40,700 persons remain to be allocated, where possible to the highest density residential land in rank order of attractiveness attached to the parcel. Assume that, in all, one assigns 8,225 persons to available parcels zoned for high-density residential use. Then the planner must assign the remaining projected population, 33,225 persons, at the medium-density use level or below. If the highest ranking parcel remaining for medium-density residential use (i.e., approximately 20 persons per acre) has 100% available land, then 200 persons would be assigned to that parcel and 33,005 persons would remain to be assigned. The assignment of remaining projected population growth will proceed in this fashion until the total projected population is allocated to parcels.

This process completed, the planner should prepare a new map for the subarea which overlaps projected land uses and population densities on a composite land use map.

2.3.5 Determination of Induced Growth

In order to isolate and determine that growth resulting specifically from the construction of wastewater treatment facilities, only the last step (i.e., spatial location of land uses) of any of these three approaches need be repeated. The only assumption which must be changed is that a wastewater treatment facility of the size and location proposed will be constructed.

The determination of how much future growth or activity will be attracted from elsewhere within the subarea to the smaller area directly served by the project involves, in part, determining what constraints are relaxed by the presence of the wastewater treatment facilities--i.e., what parcels of land can now be developed at higher densities or for a more economic use of the lot than previously? Certain parcels of land will no longer be constrained in their density of development by soil conditions; the constraint now will be the flow which can be handled by the sewers and treatment facility serving these parcels. Other parcels which were previously undevelopable, or which could be developed only at low densities due to site conditions, may now be developed profitably due to the higher density which the parcel can support. The development actions taken as a result of these changed conditions will ultimately depend on many factors, including the community's attitudes toward regulation of growth and community preferences for the residential lifestyles made feasible by new sewering.

For the first level approach (the checklist approach outlined in Section 2.3.2) the induced growth effect of the wastewater treatment facility on the distribution of population and industrial activity within the subarea is determined by asking Question #5 again, this time assuming construction of the facility. This first level approach relies mainly on informed local judgments, i.e., from planning board and staff personnel, local assessors, etc.

The second level approach introduces more explicit consideration of data on land characteristics, existing zoning, regulations and community attitudes toward growth into the analysis of secondary growth impacts. The analyst repeats Steps 3, 4 and 5 (see Section 2.3.3) assuming construction of the proposed facility, the output being a series of overlays on the existing zoning map showing anticipated changes in land use patterns given sewering.

For the third level, or land use forecasting approach, the separate impact of the provision of wastewater treatment facilities can be introduced in an even more explicit fashion. The spatial allocation of future land use changes (refer to Section 2.3.4) would be repeated, this time using a new ranking of available parcels by their attractiveness for development as reflected in changed values assigned to those parcels previously unsewered but now served by the new facility (i.e., application of criterion E). The entire sequence of allocating project growth first to industrial uses, then high-, medium-, and low-density residential uses, would be redone, with the resulting difference in the two final mappings constituting the induced growth within the service area of the treatment facility.

2.4 A Strategy for Guiding Secondary Impact Assessment

The following four chapters recommend approaches for assessing induced secondary impacts based on the growth estimates developed in this chapter. For each of fourteen types of impact, alternative impact assessment approaches are described; the choice of approach depends upon the existence and seriousness of the impact expected.

The three step procedure described in this section is intended to assist in focusing this secondary impact assessment on the impact types which are most likely to occur in the subarea being examined. This initial "screen" is intended to make the assessment of secondary impacts more efficient by: 1) identifying impacts which are unlikely to occur and can, therefore, be ignored; and 2) initially assessing the relative seriousness of impacts as a guide to application of an appropriate level of impact analysis to assess secondary impact effects.

Step 1 - The analyst should first read the introductory sections for each of the fourteen secondary impact types. The purpose of this review is to make sure that the user is familiar with the definition of each impact type and the attributes of wastewater treatment facilities (and their location) which may cause these impacts.

Step 2 - The analyst should refer to maps (developed in forecasting growth) displaying existing land use patterns and projected spatial allocation of residential, commercial, and industrial growth. For each type of induced secondary impact the analyst should answer the question:

> "Will the growth induced by the wastewater treatment facility have any impact on this area of environmental concern?"

The analyst should use his/her knowledge of the subarea and best judgment regarding probable impact to answer this question for each impact type. The answer to the question should be a characterization of probable sewer-induced impact using the following scale:

- Serious Impact - The existence and location of the wastewater treatment facility (WWTF) clearly poses a serious threat to this area of environmental concern.
- Modest Impact - The WWTF will have an impact, although ameliorating steps can be taken so there will be no fundamental threat to environmental values.

- Slight Impact - Environmental impact is likely to occur, but the WWTF will only slightly affect the environmental values.
- No Impact - The WWTF location will have no induced impact on a particular type of environmental concern.

Step 3 - The analyst should begin the process of secondary impact assessment by focusing on the impact types for which the effects are judged to be potentially "serious." Moreover, the type of secondary impact assessment done for these serious impacts should probably be at a relatively high level of sophistication.

Following the analysis of these "serious impacts" the analyst should proceed to consider successively the areas of modest and light impact, tailoring the type of analysis used to the expected seriousness of the impact.

Finally, the analyst should again check the introductions to the impact sections for those impact types for which "no impact" is expected to occur. If no impact is expected, this conclusion and the reasons for it should be stated in the introduction to the secondary impact assessment document, and these impact types should be eliminated from further consideration.

Listed below are the fourteen types of secondary environmental impacts dealt with in this manual. The list provides references to the appropriate introductory sections and space to note the anticipated seriousness of each type of impact:

	Impact Types	Introductory Material		Significance Judgment
		Section	Page	
Media Impacts	Water Quality and Quantity	3.1	34	
	Air Quality	3.2	56	
	Noise Impacts	3.3	63	
	Solid Waste Impacts	3.4	85	
Sensitive Environmental Areas	Wetlands	4.1	93	
	Coastal Areas	4.2	97	
	Flood Plains	4.3	102	
	Wildlife Habitats	4.4	108	
Unique Areas	Parkland	5.1	115	
	Wild & Scenic Rivers	5.2	121	
	Areas of Historic, Architectural, Archaeological, or Cultural Values	5.3	125	
Encounter Impacts	Agriculture Impacts	6.1	135	
	Energy Demand Impacts	6.2	143	
	Property Value Impacts	6.3	153	

3.0 MEDIA IMPACTS

This chapter is the first of four substantive chapters which provide local analysts with the capability, at several levels of precision, to characterize the specific environmental impacts of development induced into the service area by the provision of wastewater treatment facilities. The grouping of environmental impacts addressed in this chapter includes the various environmental media affected by induced growth--water, air, noise, and solid wastes.

Section 3.1 covers four major areas of impact upon Water Quality and Quantity--stormwater runoff, sediment yield, specific pollutant loadings, and the quality and quantity of water supplies.

Section 3.2 deals with impacts of induced growth on Air Quality. Recognizing the limitations on the types of analysis which can be performed locally in lieu of computer-based models, this section reviews applicable EPA regulations, stresses reconciliation of development projections with the State Implementation Plan, and refers the user to available analysis methodology including computerized techniques.

Section 3.3 provides a basis for local estimation of induced growth impacts on Noise levels emitted by highway traffic, aircraft, railroads, and general urban activity, as well as a convenient methodology for combining these estimates into one overall noise impact index.

Section 3.4 takes up the impact of induced residential and industrial development on the total amounts of Solid Waste generated in the service area, with and without the wastewater treatment facility, and relates it to available local disposal capacity.

It should be noted that potential conflicts are apparent when one examines the issue of community growth--where should it occur, be distributed, and how much should be allowed? The wastewater treatment program can induce concentration of growth along a sewer, and thereby may or may not increase overall air pollution levels. Enforcement of standards to control one kind of pollutant may exacerbate other pollution problems. (17) Moreover, pollutants originally found in one medium (air, water, or land) can migrate into another, where they might cause greater damage or be more difficult to remove. For example, nutrients, pesticides, and other chemicals applied to the land may be transported to receiving waters by leaching and runoff. Aerosols and airborne dust containing pollutants may enter surface waters as fallout or in precipitation. Wastewater treatment processes also provide pathways by which pollutants are transported from the water back to the land and air media. Land disposal of residual wastes may introduce heavy metals, pathogens, and persistent organic compounds into the human food chain. Sludge incineration can emit gases and particulates containing these same toxic substances into the air. These intermedia relationships are important, and should be considered when evaluating secondary impacts (18,19,20).

3.1 Water Quality and Quantity

An analysis of the secondary impacts of construction of wastewater treatment facilities must consider the impact of induced growth on surface and ground water quality and quantity. (21) Growth of population and associated land use changes affect water quantity by altering part or all of the natural hydrologic cycle--precipitation, infiltration, surface and subsurface runoff, and stream flow. Water quality is affected by the addition of pollutants during one or more parts of this cycle, and by discharges from man-made facilities. Figure 3.1 illustrates the significant interrelationship among the types of environmental changes resulting from urban growth and development and impacts on water quality and quantity.

While the interrelationships are complex, key variables for determining the secondary impacts of urbanization and the construction of wastewater treatment facilities include:

a. Increased total and peak runoff and reduced time of flow concentration (3.1.1)

b. Sediment yield (3.1.2)

c. Pollutant loadings (3.1.3)

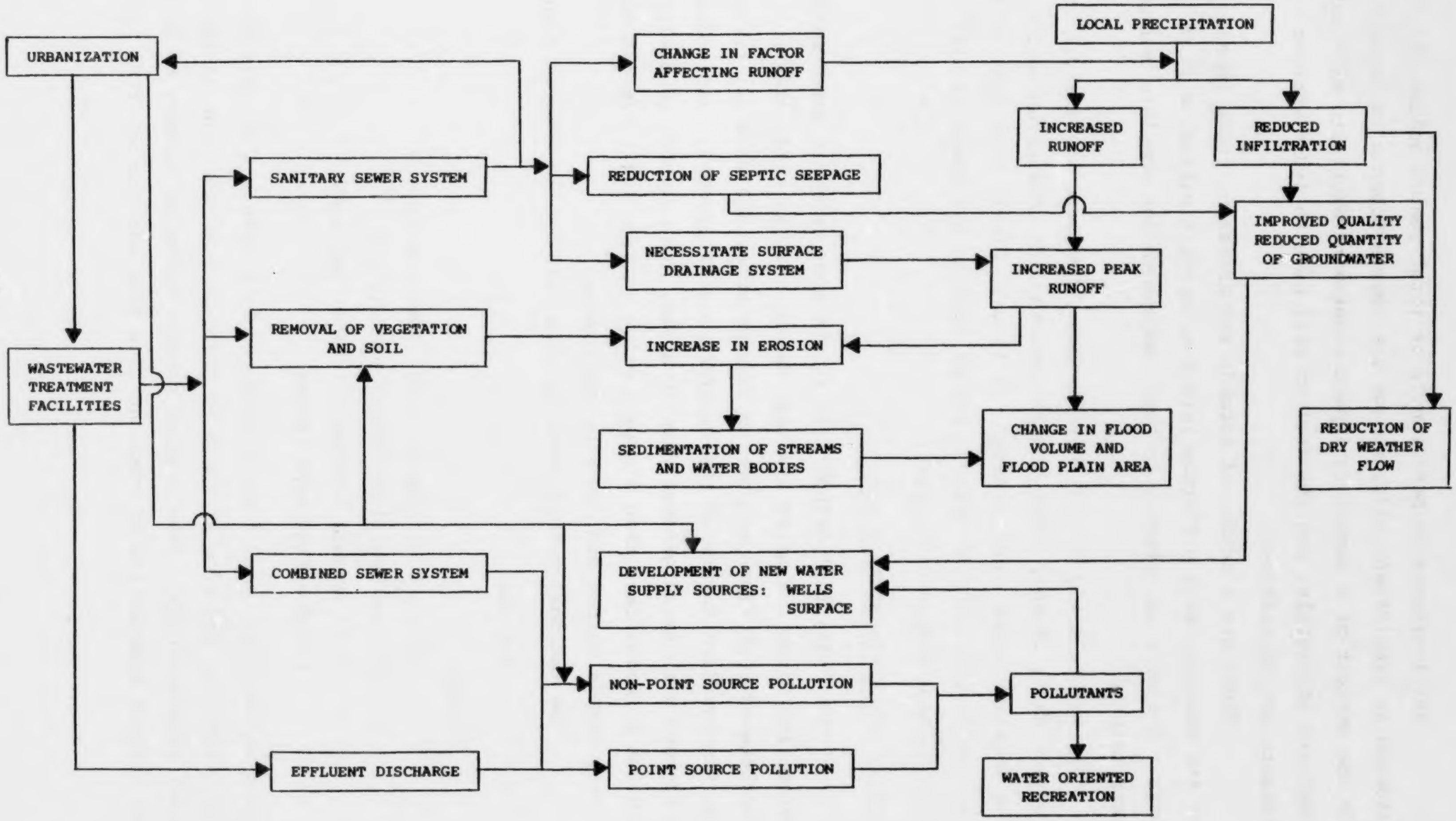
d. Quality and quantity of water supplies (3.1.4)

3.1.1 Increased Peak and Total Storm Runoff Volumes

The effect of urbanization is to increase the imperviousness of an area, thereby decreasing infiltration of rainfall into the ground. This results in increases in peak runoff and total runoff volumes, and an earlier peaking of the runoff from rainfall. Projects such as stream channelization and the installation of storm drainage systems further reduce the time of concentration of this increased runoff, resulting in even greater increases in peak flow and runoff volume. The results of these changes are increased flooding, erosion, and storm-generated pollution.

Figure 3.1

INTERRELATIONSHIPS OF URBANIZATION, CONSTRUCTION OF WASTEWATER TREATMENT FACILITIES AND IMPACT ON WATER


URBANIZATION
WASTEWATER TREATMENT FACILITIES
SANITARY SEWER SYSTEM
REMOVAL OF VEGETATION AND SOIL
COMBINED SEWER SYSTEM
EFFLUENT DISCHARGE
CHANGE IN FACTOR AFFECTING RUNOFF
REDUCTION OF SEPTIC SEEPAGE
NECESSITATE SURFACE DRAINAGE SYSTEM
INCREASE IN EROSION
SEDIMENTATION OF STREAMS AND WATER BODIES
DEVELOPMENT OF NEW WATER SUPPLY SOURCES: WELLS SURFACE
NON-POINT SOURCE POLLUTION
POINT SOURCE POLLUTION
LOCAL PRECIPITATION
INCREASED RUNOFF
REDUCED INFILTRATION
INCREASED PEAK RUNOFF
IMPROVED QUALITY REDUCED QUANTITY OF GROUNDWATER
CHANGE IN FLOOD VOLUME AND FLOOD PLAIN AREA
REDUCTION OF DRY WEATHER FLOW
POLLUTANTS
WATER ORIENTED RECREATION

Any increases in peak runoff or total runoff volume can be considered as significant (22), though the degree depends on local conditions. In the context of a secondary impact assessment each site will have to be analyzed separately, and the analyst will have to judge whether runoff impacts are significant.

There are a number of methods for assessing these impacts. Three of the methods, with differing levels of sophistication, will be outlined here. The user is referred to basic documents for complete descriptions of each method.

Before using one of these methods, however, the analyst should ascertain what, if any, urban runoff impacts were considered in the design of the facility under construction. It is very likely that some will have been evaluated, and the analyst may be able to use these results without performing a separate analysis.

3.1.2 First-Level Approach

The "rational" method (23) is the most commonly used method for estimating flows for storm drainage design. It is applicable only to predictions of peak flows and not to flow volumes, and does not account for the time-variant nature of the rainfall-runoff process. Its reliability decreases with areas greater than 10 acres, and practice generally limits its use to areas less than 5 square miles in area (24). It is, however, a very simple method and has wide acceptance.

The rational method predicts peak flow by the following equation:

$$Q = CiA$$

where:

Q = peak discharge, cubic feet per second

C = an empirical runoff coefficient

i = rainfall intensity, inches per hour

A = drainage area, acres

It is assumed that peak flow is produced by a rainfall of uniform intensity maintained for the time it takes to "concentrate" the flow at the point under consideration. This time of concentration is assumed to be equal to the longest combination of overland flow time and channel flow time which exists up to the point of concern (usually the downstream end of the catchment). Average values for the runoff coefficient for different land uses and surface characteristics are shown in Figure 3.2.

These coefficients are applicable for storms of five- to ten-year frequencies. Information on the intensity, duration, and frequency of the rainfall should be extracted from U.S. Weather Bureau data (25), unless there is better local data available. The rational formula permits one to estimate the impact of increased peak runoff by comparing a situation before and after development. In making such a comparison, one must remember that the selected rainfall intensity, i, is dependent on time of concentration, which changes when the runoff coefficient changes. It is not adequate merely to change the runoff coefficient.

For the first-level approach, the following two questions should be answered. Examples of calculations that can be used to answer these questions are provided.

1. Will the overall peak runoff increase by more than 3% (on the average) for the subarea, or more than 25% for the project service area due to the construction of the wastewater treatment facilities?

Example: A small community presently developed on 1000 acres shows the following land use pattern:

suburban residential	40%
apartment residential	12%
paved	18%
open (improved)	16%
commercial and industrial	14%

A treatment facility is planned, which will serve 1400 acres (existing area plus 400 acres which are presently undeveloped). With the facility, forecasts indicate that there will be an increase in apartment residential, resulting in a higher percentage of paved surface but lower overall development--showing as an increase in percent open (unimproved) land. It is further assumed that, even if the facility were not built, the 400 additional acres would be developed, through the development would be less dense.

Figure 3.2

Values of Runoff Coefficient For Use With Rational Formula

Land Use	Runoff Coefficients
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-family	0.30 to 0.50
Multiunits, detached	0.40 to 0.60
Multiunits, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard	0.20 to 0.30
Unimproved	0.10 to 0.30

Character of Surface	Runoff Coefficients
Pavement	
Asphaltic and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil	
Flat, 2 percent	0.05 to 0.10
Average, 2 to 7 percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average, 2 to 7 percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

Source: Design and Construction of Sanitary and Storm Sewers, ASCE Manual No. 37, (8).

The following tables summarize the difference in peak runoff with and without development. C' is a weighted runoff coefficient. The tables show, for instance, that peak runoff from the presently (1975) developed area is approximately 50% of rainfall, and that if no facility is built, the peak runoff in 1975 is 42.3% of rainfall.

1975

		1000A		1400A	
Type	C	% land use	C'	% land use	C'
suburban residential	.3	40%	.12	29%	.087
apartment residential	.65	12%	.078	9%	.059
paved	.90	18%	.162	13%	.117
percent open (unimproved)	.2	16%	.032	40%	.08
commercial and industrial	.8	14%	.112	10%	.08
		100%	.504	100%	.423

1995

		1400 Acres Without Sewers		1400 Acres With Sewers	
Type	C	%	C'	%	C'
suburban residential	.3	47%	.141	43%	.132
apartment residential	.65	14%	.09	16%	.104
paved	.9	13%	.117	13%	.117
commercial and industrial	.8	10%	.080	10%	.08
open	.2	16%	.032	18%	.036
		100%	.460	100%	.469

The overall increase in the peak runoff, with sewers, can be calculated by taking the percent increase in runoff:

$$\frac{Q_{95} - Q_{75}}{Q_{75}} = \frac{(C'iA)_{95} - (CiA)_{75}}{(C'iA)_{75}} = \frac{C'_{95} - C'_{75}}{C'_{75}} = \frac{.469 - .423}{.423} = 10.8\%$$

Note, however, that a significant amount of development would have taken place without sewers. The probable increase in the peak runoff for the development without sewers can be calculated similarly.

$$\frac{Q_{95} - Q_{75}}{Q_{75}} = \frac{C'_{95} - C'_{75}}{C'_{75}} = \frac{.460 - .423}{.423} = 8.75\%$$

Therefore, the overall increase in peak runoff for the subarea is the difference between development with and without the sewers, or 2.05%, which is less than 3%.

The analyst should now determine whether there will be an increase of more than 25% runoff for the project service area. For this example, the project service area is the additional 400 acres, which has a runoff coefficient (1975) of .20 and will have a runoff coefficient (1995) of .38 with sewers and a runoff coefficient (1995) of .35 without sewers. Therefore, the increase in the peak runoff for the project area with sewers is:

$$\frac{Q_{95} - Q_{75}}{Q_{75}} = \frac{C'_{95} - C'_{75}}{C'_{75}} = \frac{.38 - .20}{.20} = 90\%$$

The increase in the peak runoff for the project area, without sewers, is:

$$\frac{Q_{95} - Q_{75}}{Q_{75}} = \frac{C'_{95} - C'_{75}}{C'_{75}} = \frac{.35 - .20}{.20} = 75\%$$

The above calculations indicate that the increaes in peak runoff from the development of the additional 400 acres can be expected to be 90%. However, without sewers the increase would have been 75%; therefore, only 15% can be attributed to induced growth. Since this is less than 25%, these calculations indicate that the increase in peak runoff due to the construction of WWTF will not be significant.

2. Will the increase in peak runoff from the local "design" storm for the project service area exceed the average annual flow of the stream to which the project service drains by more than 5%?

Example: 400 acres of land in the previous example will undergo development changes because of the proposed sewer, increasing the runoff coefficient from .20 to .38; the rainfall intensity is assumed to be 3.0 inches per hour. Therefore, the additional peak flow from the project service area developed with sewers is equal to:

$$(CiA)_{95} - (CiA)_{75} = .18\ (3.0)\ (400) = 216 \text{ cfs}$$

The additional peak flow from the area developed without sewers (C increases from .20 to .35) is equal to:

$$(CiA)_{95} - (CiA)_{75} = .15\ (3.0)\ (400) = 180 \text{ cfs}$$

The average annual stream flow (determined from local records) is 2400 cfs. The increased peak flow due to facility construction is:

$$\frac{216 - 180}{2400} = 36/2400 = 1.5\%, \text{ which is less than } 5\%.$$

One can conclude, then, that although development (with the facility) of the additional 400 acres will have a significant impact on the stream receiving the flow from this project area, only a relatively small portion can be attributed to growth induced by the facility.

3.1.3 Second-Level Approach

Several techniques have been recently developed in an attempt to overcome the shortcomings of the "rational" method, and to provide a broader framework for the assessment of stormwater impacts. Two of these techniques will be described here. They have several attractive features, which include:

- They are simple, easy to use, and well documented.
- They recognize the time-variant nature of the rainfall-runoff process.
- They enable the user to get a "feel" for the impacts of land-use alternatives on his system.
- They provide the ability to assess water quality (see 3.1) in addition to runoff quantity.

The simpler of the two methods, at least for the user, is one outlined in the Areawide Assessment Procedures Manual (AAPM), developed for EPA by Hydroscience, Inc. and others. (26) This method, a simplified statistical method for the assessment of runoff and treatment, provides a flexible tool for the initial analysis of stormwater loads, their impacts, and alternative control strategies. It is a methodology rather than a specific computer model with fixed inputs, algorithms, and results. The basic statistical attributes of the rainfall-runoff process are used to provide simple initial estimates of the quantities pertinent to stormwater assessments. The statistical method may be applied initially without extensive data requirements and sophisticated urban runoff models. More complex models may be subsequently incorporated if more refined estimates are needed.

The statistical method begins with an analysis of rainfall, the basic driving force in the generation of stormwater loads. Raingage data is analyzed to provide a statistical summary of the rainfall process. The characteristics of the drainage area are then used to determine the runoff flow and associated pollutant load. This load may be modified by treatment or storage, either by the existing conveyance system, or by special stormwater control facilities. The stormwater loads thus developed are subsequently applied to the receiving water to determine the severity of their impacts. Figure 3.3 summarizes the method. The method uses the coefficient of variation of each parameter and cumulative density functions to enable the user to calculate the number of times, over a specific period, that a given parameter value will be exceeded.

Copies of the referenced publication are available from:

Municipal Environmental Research Laboratory
U.S. Environmental Protection Agency
26 West St. Clair Street
Cincinnati, Ohio 45268

The second of the two methods is called a Simplified Stormwater Management Model (27). While simpler conceptually than the previous method described in AAPM, this method does require more work on the part of the user, since it is a combination of hand computations and small computer programs. The chief advantage of this method is that it allows, on a site-specific basis:

a. Analysis of the total system and its interactions.

b. The establishment of size-effectiveness relationships of various treatment/storage alternatives.

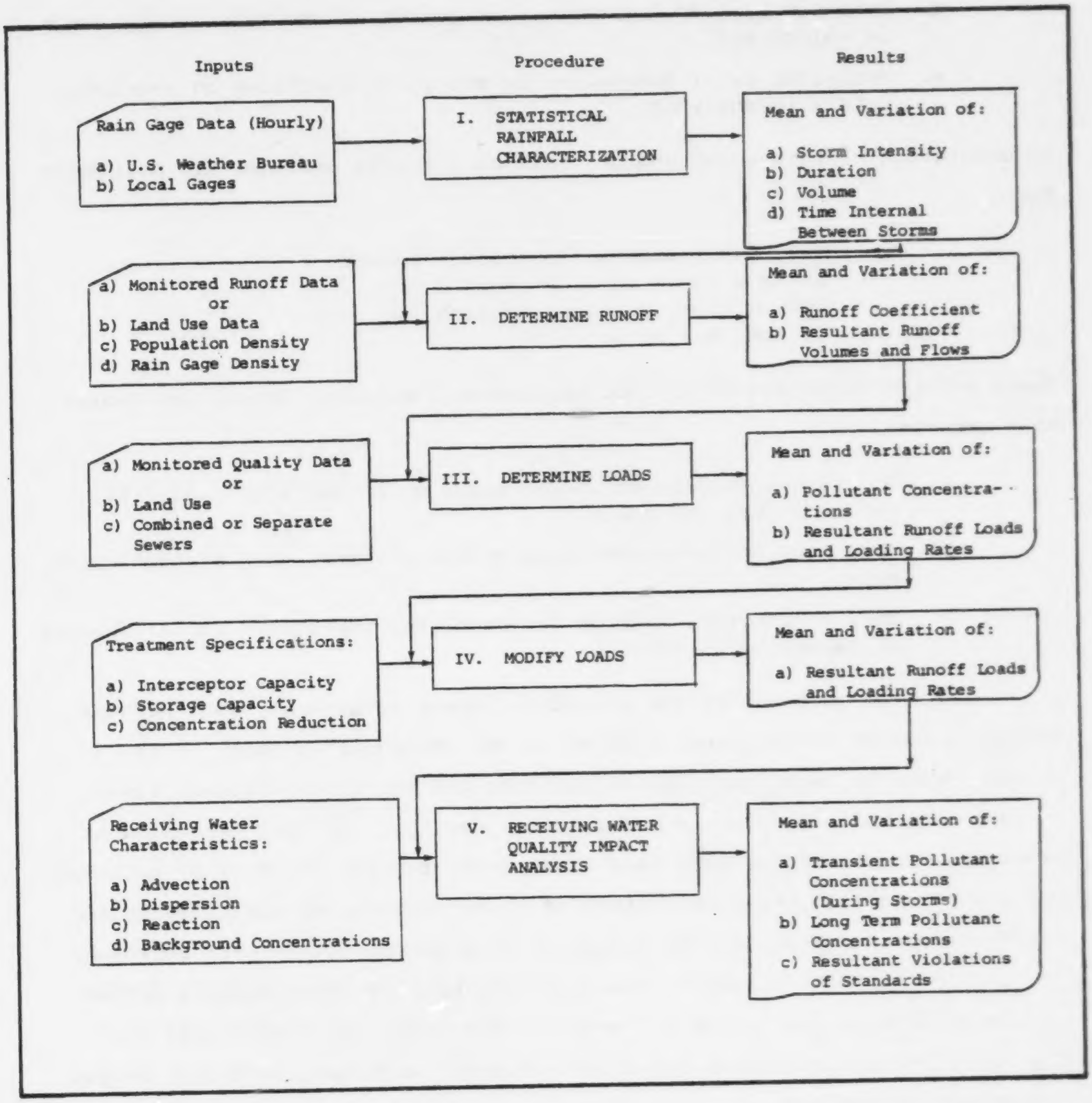
In applying the Simplified Model, five tasks are performed:

a. Data Preparation, which includes schematization of the system and gathering of data on overflow quantities and qualities.

b. Rainfall Analysis--raw rainfall data from the local area are collected and analyzed, and critical rainfall characteristics are ranked.

Figure 3.3

STATISTICAL METHOD FOR THE ASSESSMENT OF RUNOFF


Inputs
Procedure
Results
Rain Gage Data (Hourly)
a) U.S. Weather Bureau
b) Local Gages
I. STATISTICAL RAINFALL CHARACTERIZATION
Mean and Variation of:
a) Storm Intensity
b) Duration
c) Volume
d) Time Internal Between Storms
a) Monitored Runoff Data
or
b) Land Use Data
c) Population Density
d) Rain Gage Density
II. DETERMINE RUNOFF
Mean and Variation of:
a) Runoff Coefficient
b) Resultant Runoff Volumes and Flows
a) Monitored Quality Data
or
b) Land Use
c) Combined or Separate Sewers
III. DETERMINE LOADS
Mean and Variation of:
a) Pollutant Concentrations
b) Resultant Runoff Loads and Loading Rates
Treatment Specifications:
a) Interceptor Capacity
b) Storage Capacity
c) Concentration Reduction
IV. MODIFY LOADS
Mean and Variation of:
a) Resultant Runoff Loads and Loading Rates
Receiving Water Characteristics:
a) Advection
b) Dispersion
c) Reaction
d) Background Concentrations
V. RECEIVING WATER QUALITY IMPACT ANALYSIS
Mean and Variation of:
a) Transient Pollutant Concentrations (During Storms)
b) Long Term Pollutant Concentrations
c) Resultant Violations of Standards

c. Storage-Treatment Balance--rainfall is imposed on the area under consideration and runoff is calculated. The interrelationship between storage and treatment is also analyzed.

d. Overflow Quality Assessment--magnitude of overflow constituents is calculated.

e. Receiving Water Response--the effect of overflows on receiving waters is analyzed.

Documentation of this model and the related computer programs are available from:

U.S. Environmental Protection Agency
Storm & Combined Sewer Section
Edison Water Quality Research Lab
Edison, New Jersey 08817

These methods (AAPM and Simplified Stormwater Management Model) are desirable because:

a. Runoff quantity is estimated based on actual local rainfall, not on a "design" storm.

b. They make no pretenses at providing any more than a rough estimate.

c. They incorporate methods for examining impacts of runoff changes on receiving waters.

For the purposes of the secondary impact assessment, both methods utilize a runoff coefficient, similar to the "rational" method. Both methods describe techniques for calculating the runoff coefficient based on such factors as land use and population density. Initial estimates of secondary impacts may be made (and first level results checked) by calculating runoff coefficients under either of these methods and substituting the coefficients so derived in the equations used in the first-level approach.

It should be stressed, however, that both of these methods differ considerably from the "rational" method. The potential user should read the reference documents and familiarize himself with each technique before attempting to use them.

3.1.4 Third-Level Approach

In most cases, the second-level approach will be adequate to describe the secondary stormwater runoff effects. In those few cases where the second level is not adequate, it will be appropriate to use one of a number of computer-based mathematical models of the rainfall/runoff process. These have been well documented in an appendix to the AAPM, and are listed in Figure 3.4. Most of them include water quality considerations, and two also model erosion and sedimentation. The models listed are of varying degrees of complexity, and differ greatly in input data requirements. All, however, require some skill on the part of the user, particularly in the interpretation of results.

3.1.5 Increased Sediment Yield

Sedimentation is the result of a physical process by which water removes and transports soil particles from one place and deposits them in another. The amount of sedimentation depends upon the water's velocity and volume and soil characteristics. The process of erosion with resulting sedimentation is one which occurs when natural forces expose earth to the forces of water. However, it is a process to which the activities of man greatly contribute; the average sediment yield from the landscape and the condition of stream channels tend to change with the advancing forms of man's land-use activities. The intensity, rate of change, and scale of development all affect the production of sediment. Therefore, sedimentation is likely to be most severe during the construction period and can continue until the surface and channel have again become stabilized, by natural vegetation or man-made intervention.

Sediment yield in streams flowing from forest and natural areas is considered negligible; even at peak periods of flow, the water is usually of high quality. Sediment yields in streams flowing from already urbanized watersheds vary from approximately 200 to 500 tons per square mile per year. In comparison, areas in the process of urbanization often show sediment yields of from 1,000 to 100,000 tons per square mile per year. (28) The basic data available for analyzing the effect of urbanization on sediment yield, though sparse, have been summarized for easy reference in several publications (29,30) and handbooks. (31,32,33,34) The user of this manual should probably be familiar with at least one of these sources.

Environmental impacts associated with increased sediment yield often result from the following construction practices:

1. Large areas exposed to storm runoff and soil erosion.
2. Increased volumes of storm runoff, accelerated soil erosion, and higher peak flows caused by:

Figure 3.4

URBAN/NON-URBAN DRAINAGE MODELS

MODEL ORIGIN	MODEL ACRONYM	Catchment Hydrology							Sewer Hydraulics								Wastewater Quality									Miscellaneous					
		Multiple Catchment Inflow	Dry-Weather Flow	Input of Several Hyetographs	Snowmelt	Runoff From Impervious Areas	Runoff From Pervious Areas	Water Balance Between Storms	Flow Routing In Sewers	Upstr. and Downstr. Flow Control	Surcharging and Pressure Flow	Diversions	Pumping Stations	Storage	Prints State	Prints Velocities	Dry-Weather Quality	Stormwater Quality	Quality Routing	Sedimentation and Scour	Quality Reactions	Wastewater Treatment	Quality Balance Between Storms	Receiving Water Flow Simulation	Receiving Water Quality Simulation	Continuous Simulation	Can Choose Time Interval	Design Computations	Real Time Control	Applied to Real Problems	Computer Program Available
Corps of Engineers	STORM				●	●	●	●				●		●				●			●		●			●				●	●
Env. Protection Agency	SWMM	●	●	●		●	●		●	●	●	●	●	●			●	●	●	●	●	●		●	●		●	●		●	●
Hydrocomp	HSP	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●		●		●	●	●	●	●		●	●	
Massachusetts Inst. of Technology	MITCAT	●	●	●	●	●	●		●		●	●		●	●	●								●			●			●	
Dorsch Consultant	HVM-QQS	●	●	●		●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●		●			●	
Metcalf & Eddy		●			●	●	●	●						●				●				●	●			●				●	●
Water Resources Engineers	AGRUN	●	●	●		●	●		★	★	★	★	★	★			★	★	★	★	★	★		★	★		●			●	
Ill. State Water Survey	ILLUDAS	●	●	●		●	●		●					●	●												●	●			●

★ AGRUN is an alternative "Runoff" block for use with SWMM, and these features are available in the SWMM.

    a. Removal of existing protective vegetative cover.

    b. Exposure of underlying soil or geologic formations less pervious and/or more erodible than original soil surface.

    c. Reduced capacity of exposed soils to absorb rainfall due to compaction caused by heavy equipment.

    d. Enlarged drainage areas caused by grading operations, diversions, and street construction.

    e. Prolonged exposure of unprotected disturbed areas due to scheduling problems and/or delayed construction.

    f. Shortened times of concentration of surface runoff caused by altering steepness, distance, and surface roughness and through installation of "improved" storm drainage facilities.

    g. Increased impervious surfaces associated with the construction of streets, buildings, sidewalks, paved driveways, and parking lots.

3. Alteration of the ground water regime, adversely affecting drainage systems, slope stability and survival of existing and/or newly established vegetation.
4. Creation of exposures facing south and west that may hinder plant growth due to adverse temperature and moisture conditions.
5. Exposure of subsurface materials that are rocky, acid, droughty, or otherwise unfavorable to the establishment of vegetation.
6. Adverse alteration of surface runoff patterns of construction and development.

There are a number of basic principles which can be followed in order to significantly reduce erosion and sedimentation from developing areas:

1. Fit the development to the particular topography, soils, waterways and natural vegetation at the site.
2. Expose the smallest practical area of land for the shortest possible time.
3. Apply soil erosion control practices at all times against possible on-site damage.
4. Apply "sediment control" practices as a perimeter protection to prevent off-site damage.
5. Implement a thorough program for maintenance and follow-up.

Typically, these five principles are integrated into a system of vegetative and structural control and prevention, along with management techniques designed to prevent or minimize sediment yield. A combination of limited grading, limited time of exposure, and a judicious selection of erosion control practices and sediment-trapping facilities will often prove to be the most practical method for controlling erosion and the transport and sedimentation of resulting soils.

3.1.6 First-Level Approach

If modeling work has been done during facility planning or design, or during water quantity analysis in preceding Section 3.1.1, the analyst should determine if the model used is capable of estimating erosion and sediment. If so, this is probably the best way to determine impacts. If not, a simple checklist for assessing the potential seriousness of the sedimentation impact resulting from development induced by a wastewater treatment facility would include the following three questions:

1. Are there local standards and specifications for erosion and sediment control in the project subarea?

If yes, these standards and specifications should be enumerated. Probable sources of information include U.S. Soil Conservation Service (SCS) field offices and local planning boards.

2. Are there standards and specifications adequate to solve potential erosion and sedimentation problems?

Areas of potential problems can be identified by assuming that the extent of the problem is directly related to expected changes in runoff, as determined in Section 3.1.1. The analyst has to make a judgment whether the control practices and principles are adequate to solve the potential problems.

3. Is there adequate enforcement of these standards and specifications?

The determination of whether enforcement actually occurs is a difficult task. Probable sources of information include planning boards, the field offices of SCS, building inspectors, and local developers.

3.1.7 Second-Level Approach

If the manual user cannot answer a definite "yes" to the above questions, there are potential sedimentation problems which should then be identified and described. Specific sites should be identified and mapped where:

1. Large parcels under single ownership would be suited to large-scale development.
2. Underlying soil and geological formations are comparatively impervious and/or more erodible than the original soil cover.

3. Heavy construction equipment will be required. leading to compacting of the soil and exterior removal of veqetation.

4. Heavy grading operations will be required, or drainage divisions or street construction will be needed to accommodate expected development.

5. Shortened times of concentration are projected due to alterations in slope, distance and surface roughness and installation of drainage facilities.

This set of maps should enable the analyst to identify problem areas and, by matching them against local erosion and sedimentation control practices, allow him to determine potential remedies. If these remedies are enforceable by law, then there is a potential solution to the negative impact. If not, then the potential impact and the area in which it will likely occur should be clearly defined.

3.1.8 Third-Level Approach

As described previously in Section 3.1.1, mathematical models may be used in estimating impacts from erosion and sedimentation. The user is referred to Figure 3.4 for information on which of the models are appropriate. The AAPM also includes provisions for estimation of erosion and sedimentation.

3.1.9 Increased Pollutant Loadings

Pollutants are discharged into the nation's waters from various sources categorized as "point" and "nonpoint." The goals of the Federal Water Pollution Control Act (PL 92-500) are that the discharge of pollutants into navigable water be eliminated by 1985 and that wherever attainable an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on to the water be achieved by July 1, 1983.

If one assumes that new point sources attracted to the service area due to sewering are likely to be controlled by discharge regulations and the sewer treatment facility itself, then the principal uncontrolled discharges will be from nonpoint sources. The analyst's problem, therefore, is to determine, for that increment of additional development in the service area due to the project, what the impact will be on nonpoint loadings. It is becoming increasingly clear that nonpoint sources have significant, if not overriding, importance on urban water quality, particularly if all point sources receive the equivalent of secondary or higher treatment. One study (35) compared contribution of urban runoff and municipal wastes to the total potential stream loading. The study found that even if the municipality were to remove all organics and suspended solids from municipal wastes, the net reduction in total raw waste components would be comparatively small, due to pollutants in the urban runoff (a total reduction of only 52 percent of the COD, 59 percent of the ultimate BOD and only 5 percent of the total suspended solids, on an average annual basis). The pollutants were the greatest during wet-weather periods, when the stormwater contributed 82 percent of the COD, 77 percent of the BOD and 99 percent of the suspended solids.

Before analyzing these effects, however, the analyst should review the facility planning documents. As stated previously, it is highly likely that some analysis of nonpoint sources has already been done, or that at least pertinent local data have been gathered to support estimates of secondary impacts.

3.1.10 First-Level Approach

At this level, the analyst uses data gathered on a national basis to make gross estimates of secondary impacts. These data are derived from research in a limited number of urban areas and should not be used for purposes other than making first-level approximations of water quality impacts.

One estimate of annual nonpoint loads from various types and intensities of land use is shown in Figure 3.5. (36,37) These estimates, in conjunction with projections made in Chapter 2 of the number of additional acres of each land use type resulting from the installation of the sewers, can be used to make very rough estimates of increased pollution levels.

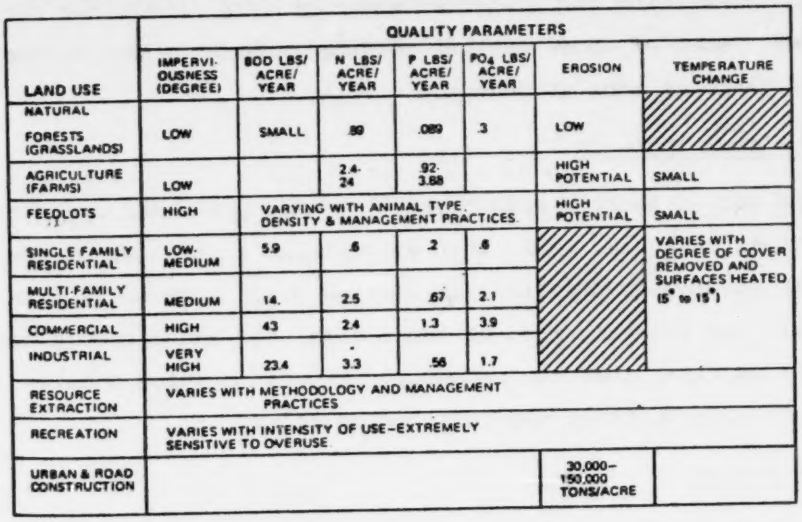
If, after having made these very rough estimates, it appears that increased pollutant loadings will result, the second level of analysis should be undertaken.

3.1.11 Second-Level Approach

For analysis at this level, the Simplified Storm Water Management Model (27) or the Areawide Assessment Procedures Manual (26), previously described in Section 3.1.1, should be used.

Figure 3.5

Annual Non-Point Pollutional Loads by Land Use Type



LAND USE	QUALITY PARAMETERS						
	IMPERVIOUSNESS (DEGREE)	BOD LBS/ ACRE/ YEAR	N LBS/ ACRE/ YEAR	P LBS/ ACRE/ YEAR	PO_4 LBS/ ACRE/ YEAR	EROSION	TEMPERATURE CHANGE
NATURAL FORESTS (GRASSLANDS)	LOW	SMALL	.89	.089	.3	LOW	▨
AGRICULTURE (FARMS)	LOW		2.4-24	.92-3.88		HIGH POTENTIAL	SMALL
FEEDLOTS	HIGH	VARYING WITH ANIMAL TYPE, DENSITY & MANAGEMENT PRACTICES.				HIGH POTENTIAL	SMALL
SINGLE FAMILY RESIDENTIAL	LOW-MEDIUM	5.9	.6	.2	.6	▨	VARIES WITH DEGREE OF COVER REMOVED AND SURFACES HEATED (5° to 15°)
MULTI-FAMILY RESIDENTIAL	MEDIUM	14.	2.5	.67	2.1		
COMMERCIAL	HIGH	43	2.4	1.3	3.9		
INDUSTRIAL	VERY HIGH	23.4	3.3	.56	1.7		
RESOURCE EXTRACTION	VARIES WITH METHODOLOGY AND MANAGEMENT PRACTICES						
RECREATION	VARIES WITH INTENSITY OF USE–EXTREMELY SENSITIVE TO OVERUSE.						
URBAN & ROAD CONSTRUCTION						30,000–150,000 TONS/ACRE	

Source: Environmental Impact, Proceedings of the ASCE Urban Transportation Division Specialty Conference, Chicago, 1973, p. 193.

Definitions:
BOD - Biochemical Oxygen Demand
N - Nitrogen
P - Phosphorous
PO_4 - Phosphate

"Universal" equations for predicting urban stormwater pollution: (37)

Total Suspended Solids (mg/l) = 147 + 2.58 x (fall (in feet) of watershed)

Total Solids (mg/l) = 332 + 31.0 x (percent unused space)

BOD (mg/l) = 12.9 - 0.362 x (percent unused space)

BOD (mg/l) = 63.5 - 0.956 x (mean annual number of thunderstorms)

COD (mg/l) = 865 - 14.7 x (mean annual number of thunderstorms)

Suspended Solids (mg/l) = 5031 - 93.5 x (mean annual number of thunderstorms)

COD (mg/l) = 377 - 3.14 x (mean annual number of days with minimum $\leq 32^{\circ}$F)

COD (mg/l) = 438 - 0.0843 x (mean seasonal number of degree days)

COD (mg/l) = 374 - 7.15 x (mean annual precipitation (in.))

Median Fecal Coliform (thousands/100 ml) = 287 - 6.78 x (mean annual precipitation (in.))

Median Fecal Coliform (thousands/100 ml) = 279 - 2.94 x (mean annual no. of days with minimum $\leq 32^{\circ}$F)

To determine the potential seriousness of the water quality impacts of the development induced by sewering, it is necessary to evaluate these impacts on existing and projected water quality levels for the affected streams. Both of these methods include techniques for evaluating the impact of nonpoint sources on water quality.

3.1.12 Third-Level Approach

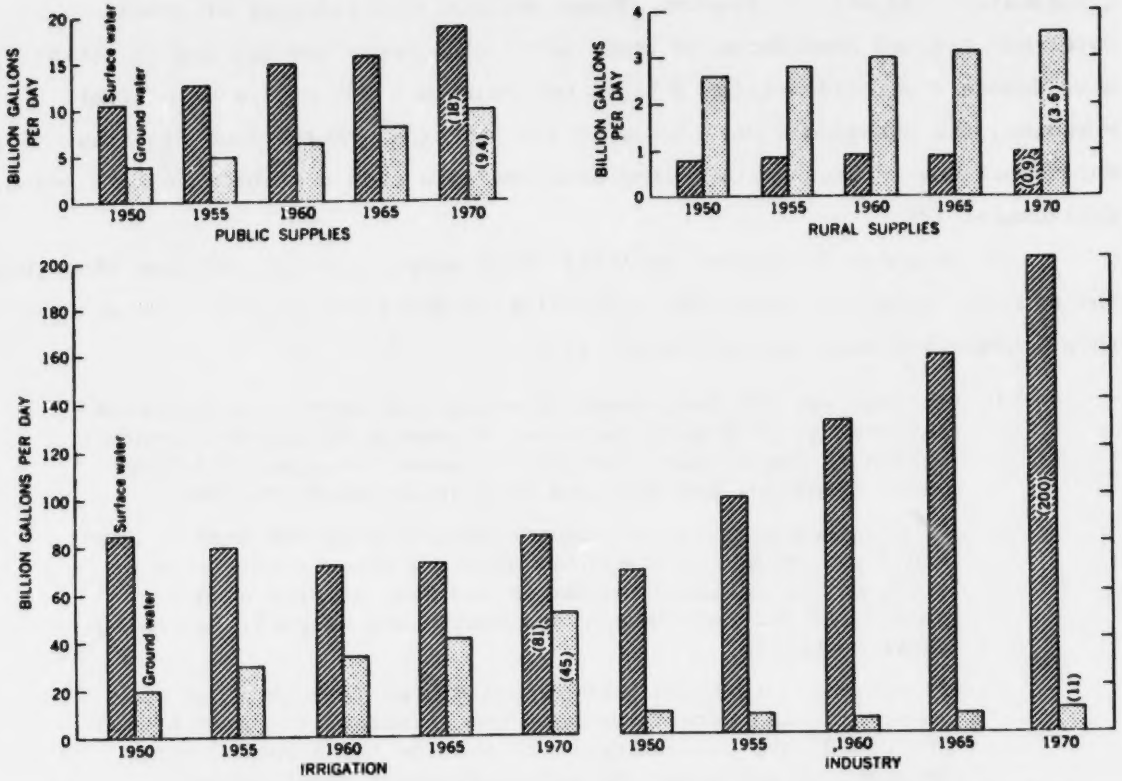
If the second level approach still reveals potential problems requiring further analysis, it is then appropriate to use one of the mathematical models previously described in Section 3.1.1. These require considerable skill and the gathering of local data, and hence should not be used unless it is clear that the secondary impacts on water quality are so important as to warrant these expenditures of effort.

3.1.13 Water Supply

Water is a resource which may be used several times for different purposes. Therefore, the demands for water use are not necessarily additive. Moreover, there can be conflicting water uses; for example, an industry locating in a rural area may depend on a large groundwater supply. The industrial demand may lower the water table significantly, thereby forcing surrounding residences to have new wells drilled. Water for public and private supply systems comes primarily from two sources: ground water and surface water. Figure 3.6 shows the trends in water for public supplies, rural supplies, irrigation, and self-supplied industry, for the period 1950-1970. (38) (The reader should note that, for all of these uses except rural supplies, surface water is the principal source.)

Projection of water use is a difficult task, for use depends upon demand for water by different users, the management of water resources, and requirements for an assured quantity and quality. Serious degradation of both surface and groundwater quality has occured in parts of the U.S. (39) In terms of quantity, a comparison of national requirements and supplies indicates an adequate water supply, although there are and will continue to be severe problems in localized areas. (40) There are serious water quality problems in parts of the Northeast and in some areas of the West, and limited water supplies are a threat in the West and Southwest. (41,42)

Figure 3.6



Graphs showing trends in use of water for public supplies, rural supplies, irrigation, and self-supplied industry, 1950–70.

Source: Estimated Use of Water in the United States in 1970 (38)

The excessive "mining" of ground water--for agriculture, industrial and domestic purposes--has resulted in salt-water intrusion and subsidence of land. For example, various coastal areas--Southern California; Dade County, Florida; Long Island, N.Y.; and some areas in New Jersey and Delaware--have experienced saltwater intrusion due to the heavy withdrawal of groundwater. (43,44) In Houston, Texas, excessive withdrawal of groundwater has created subsidence of land, up to nine feet, and has led to extensive damage (over $14 million dollars per year in a 300 square mile area). Moreover, the subsidence has increased the potential damage from flooding. (45) Subsidence due to groundwater withdrawal has also been a problem in Long Beach, California. (46)

In response to serious drinking water supply quality problems throughout the country, Congress passed the Safe Drinking Water Act of 1974. In general, this legislation does the following: (47)

1. It requires the Environmental Protection Agency to prescribe national primary drinking water standards designed to protect health to the extent feasible; national secondary drinking water standards are designed to protect public welfare.
2. It provides primary enforcement authority to the States, provided the States have adopted drinking water regulations as stringent as national standards and have adopted adequate procedures for enforcement and monitoring of public drinking water supplies.
3. It provides, in those cases where States fail to adopt adequate drinking water standards and enforcement measures, that EPA would have the authority to enforce the drinking water regulations and grant variances, wherever practicable.
4. It establishes a program for the protection of underground sources of drinking water.
5. It provides for the emergency allocation of chlorine to public drinking water systems.

Under this Act, states have primary enforcement responsibility for public water systems, provided that EPA determines that the states have adopted drinking water regulations as stringent as the national standards, as well as adequate procedures for enforcement and maintenance of records. The Act also requires regulation by States for underground injection control programs. These regulations must contain minimum requirements for effective programs to prevent the endangerment of underground drinking water sources due to injection.

An approach to assessing the impacts of sewer-induced development on water supply should incorporate the following major steps:

Step 1. For the projected population, with and without sewers, determine the probable source of water supply.

Development without sewers may necessitate development of a public water supply from a source which will not be contaminated by septic systems.

Step 2. For the probable source of water supply, estimate its quantity, quality and dependability.

The availability of groundwater is very difficult to establish, and can perhaps be estimated best by determining the extent the water table has dropped over a period of time when additional wells have used this as the source. Additional data, such as estimating the aquifer recharge using U.S. Geological Survey data, can provide insight into the quantity of groundwater which is probably available. The availability of surface water as a water supply system usually necessitates the construction of a holding structure, and therefore the start of a public water supply system. Dependability of such a system will depend upon its design.

Step 3. Determine the demand for water for the projected populations with and without sewers.

The quantity of water used per capita is a key concern in the design of wastewater treatment facilities. One hundred gallons per person per day is a figure commonly used by design engineers for residential consumption. However, higher per capita consumption is often realized, depending on the locality and local industrial use. The dilemma is whether to accept some "standard" projected per capita consumption or to use that projection based on present actual consumption. An error in this judgment could have the same effect as an error in estimating future population: capacity greater than use will necessitate increased costs; capacity less than demand will necessitate fewer residences being able to concentrate along the sewer and to use the facility.

One should also ascertain whether the probable source of water selected to support the projected development in the subarea is not also that believed to be the source for another nearby subarea. If so, then, it is necessary to note this and to determine the probability of the immediate subarea utilizing this source.

Step 4. Compare the probable source of water (along with its quality and dependability) to the expected demand, and rationalize any difference; this should be done for the expected development with and without sewers.

In areas where water demand exceeds supply, in terms of quality or quantity, water supply is a limiting factor on population growth. If this is the case, then the initial population projection should be revised, and previous work based on the higher projection redone.

3.2 Air Quality

3.2.1 Introduction

Under the Clean Air Act Amendments of 1970, the Environmental Protection Agency is responsible for establishing national standards for ambient air quality (primary standards to protect health, and secondary standards to protect the public welfare, specifically property, vegetation, and aesthetics). (48) In April 1971, EPA established standards for major air pollutants--sulfur dioxide (SO_2), particulate matter, carbon monoxide (CO), hydrocarbons (HC), nitrogen dioxide (NO_2), and photochemical oxidants. (49) These standards are summarized in Figure 3.7. These national ambient air quality standards (NAAQS) became the basis for the development of State Implementation Plans (SIPs) by mid-1972. Each state was required to adopt and submit to EPA a plan which provided for the attainment and maintenance of these national ambient air quality standards within each air quality control region, or portion thereof.

A successful court suit brought by the Natural Resources Defense Council forced EPA to reject the first round of State Implementation Plans developed under the 1970 legislation because they failed to include adequate measures to maintain national ambient air quality standards once attained. While most SIPs had adequate maintenance provisions to ensure that major stationary sources did not by themselves cause the standards to be exceeded, few plans had specific provisions to ensure that standards would not be exceeded due to (1) clustering of mobile sources, (2) clustering of small point sources which individually were not subject to review, (3) rapid and extensive growth of area sources such as light industry, and (4) major shifts in population centers with associated residential and commercial growth.

Figure 3.7: NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

Pollutant	Type of Standard	Averaging Time	Frequency Parameter	Concentration	
				ug/m^3	ppm
Carbon monoxide	Primary and secondary	1 hour	Annual maximum[a/]	40,000	35
		8 hours	Annual maximum	10,000	9
Hydrocarbons (nonmethane)	Primary and secondary	3 hours (6 to 9 a.m.)	Annual maximum	160[b/]	0.24[b/]
Nitrogen dioxide	Primary and secondary	1 year	Arithmetic mean	100	0.05
Photochemical oxidants	Primary and secondary	1 hour	Annual maximum	160	0.08
Particulate matter	Primary	24 hours	Annual maximum[a/]	260	-
		24 hours	Annual geometric mean	75	-
	Secondary	24 hours	Annual maximum	150	-
		24 hours	Annual geometric mean	60[c/]	-
Sulfur dioxide	Primary	24 hours	Annual maximum[a/]	365	0.14
		1 year	Arithmetic mean	80	0.03
	Secondary	3 hours	Annual maximum	1,300	0.5

a/Not to be exceeded more than once per year.

b/As a guide in devising implementation plans for achieving oxidant standards.

c/As a guide to be used in assessing implementation plans for achieving the annual maximum 24-hour standard.

Source: U.S. Environmental Protection Agency, "Natural Primary and Secondary Ambient Air Quality Standards." (49)

In response, EPA developed a new planning approach: preparation of Air Quality Maintenance Area (AQMA) plans. The AQMA Planning Program is aimed at long-range planning solutions. In requires states, as an amendment to their SIP, to designate areas which, due to projected growth rates, may present threats to continued maintenance of air standards. Over 150 such AWMAs have been so designated, the vast majority representing the major urbanized areas of the country; however, a few AQMAs are areas which, although currently sparsely populated, are expected to undergo massive development in the relatively near future. AQMA analysis will project population and economic growth for at least the next 10 years and determine the impact of that growth on air quality. The effects of existing controls are to be factored into the analysis, and if the results show that these controls are indeed adequate to ensure maintenance of standards, then no further action is necessary. However, it is anticipated that in most AQMAs existing controls will not be adequate because, in the development of these controls, the combined impact of new large point sources and the multitude of new small sources typical of high-growth urbanizing areas were not sufficiently considered. In these cases, AQMA plans have to be developed, consisting of those additional regulations and/or modifications to existing regulations necessary to ensure maintenance of air quality standards in the future. These will be primarily land use and transportation control measures. In the future, states will be required to reassess these air quality maintenance areas at intervals of not more than five years. Guidance for states in planning for these problem areas is available in EPA's multi-volume Guidelines for Air Quality Maintenance Planning and Analysis. (50)

A second successful court suit, this one brought by the Sierra Club, challenged EPA's practice of allowing deterioration of air quality in relatively clean areas. As a result, no "significant deterioration" will be allowed in these areas in the future. The current EPA regulations covering particulates and SO_2 have three important features: (1) all new major sources in nineteen specified categories must incorporte best available control technology regardless of where they are located, (2) states must define, with extensive public participation, and within the framework of the federal regulations, what the term "significant deterioration" means in their areas, and (3) any major new source whose construction would violate that concept of significant deterioration would be prohibited from locating in that area. These regulations will have a direct impact only on large industrial sources. One effect will be to identify certain areas of the country where major pollution-prone industrial growth is essentially prohibited. Implicit in this will also be conscious local decisions regarding those areas in which major industry is to be attracted; hence, the effect will be to provide a priori guidance to industry where to locate major new facilities. Moreover, it is important to realize that any growth and development, with resulting emissions of SO_2 or particulate matter, could "use up" the increment associated with each of the following classifications, thus precluding any of the 19 sources from locating in the area in the future.

The nonsignificant deterioration regulations provide for state designation of all areas within their jurisdiction under one of three types:

> Class I areas: practically any change in air quality would be considered significant.
>
> Class II areas: deterioration normally accompanying moderate, orderly growth would be considered insignificant.
>
> Class III areas: deterioration up to a national standard would be considered insignificant. (51)

However, areas that pervasively exceed national standards for particulate matter or sulphur dioxide are exempt from classification. All other areas are classified as Class II until a state chooses to reclassify them.

It is important to understand that the AQMA plan--and similarly the transportation control plan, the regulations to prevent significant deterioration, and the provisions for indirect source review--constitutes an integral part of the State Implementation Plan (SIP). The choice of specific actions that are needed to maintain the national air quality standards are those selected by each state, which has developed the SIP using the technical and procedural framework provided in EPA regulations. It is therefore imperative that the user of this manual determine, in the First-Level Approach, whether the projected growth for the subarea will be in accord with the SIP (and therefore all of its components). In the Second-Level Approach, which should be used whenever the projected growth does not meet all the constraints of the First-Level, one should consult with the appropriate State agency responsible for air pollution control in order to determine the available information and technical approaches used to project and allocate air pollution emissions.

3.2.2 First-Level Approach

The future air quality of the subarea will depend upon population growth and distribution of that population in the region. In a subarea for which growth projections indicate that there will be no construction of major stationary or indirect sources (including highway construction), there probably will be no significant air quality impact warranting further analysis, assuming the following conditions hold:

- The population growth rate will not exceed an annual average of .75% over the next twenty years (this is based on the present national population growth rate being 7.5 per 1000 and the fact that this average growth has to be accommodated.)
- There are no special local resources whose future development and/or expansion could lead to accelerated population growth (e.g., energy sources, unique recreational opportunities, etc.).
- Industrial growth over the next twenty years will not exceed 1% per year, as meaured by employment opportunities (this is based on the estimated average annual national increase in employment opportunities).
- No more than 15% of the total land use in the subarea is expected to change use in the next twenty years (this was determined by multiplying .75% by 20 years).
- No projected growth and distribution are in accord with the SIP.
- No part of the subarea is part of a designated AQMA or an area for which there exists transportation control plan.

Most of the data needed to determine if these conditions hold is available from the analysis done earlier in Chapter 2, or the State agency responsible for air pollution control. It should be recognized that although certain variables, such as changes in technology, could lead to growth patterns different from those projected, one has to carry out the present analysis using the best data available. (52)

3.2.3 Second-Level Approach

In cases where any or all of the conditions of the First-Level Approach do not hold for a particular subarea, the Second-Level Approach should be used. Current EPA regulations (53), require that the SIP idenfify areas that may, as a consequence of current air quality and/or the air quality associated with the projected growth rate for the area, have the potential for exceeding a national standard within a ten-year forecast period.

The EPA Administrator presently can specify: (1) those areas that need plans from among those he has or will have identified as problem areas; and (2) individual dates for submission of each area's analysis and plan depending on the individual needs of each area. (52) As of October 20, 1975 the EPA had identified a total of one hundred and sixty-eight AQMA's for at least one pollutant. (52)

The analyst should determine from the State agency responsible for air pollution the following:

- whether the subarea is in an area where there is now, or is expected to be in the next 20 years, inadequate attainment or maintenance of air quality standards;
- the standards which have been or might be violated;
- the current and forecast levels of pollutants for the subarea; and
- the transportation plan and its process of implementation and controls (for this could affect the projected population distribution).

In some situations, the analyst may have to refer to computer models which simulate air quality conditions in complex situations. If such a model is used, it is critical that the modeling be consistent with the regulations which are expected to be in effect when the WWTF is constructed. The state agency or other lead agency involved should be able to provide this information.

This information should assist in addressing the following questions:

1. Will future growth violate National Ambient Air Quality Standards?

Whether future growth will violate the NAAQS depends, among other things, upon the effective implementation of the SIP to reduce or eliminate present sources of pollutants and to control future sources. The extent to which future growth in the subarea will contribute to a potential violation can be estimated based on the proportion of the subarea's population to the total population for the area. Application of this simple algorithm is based on the assumption that the concentration at a location is directly proportional to the overall emissions in the environs; e.g., (for nonreactive pollutants) the pollution is proportional to the distribution of population. Therefore, any reductions in emissions which are reflected in proportional improvements in air quality through the area are in proportion to the population.

2. Will projected growth and the resulting pollution be consistent with the conditions established in the State Implementation Plan?

Whether future growth and resulting pollutants will be in accord with the SIP will depend upon its maintenance provisions and the enforcement of the regulations which are part of the SIP. This enforcement strategy includes review of new and modified sources (stationary and indirect), control strategies, review of transportation plans, air quality monitoring, and enforcement actions.

3. Will future growth violate any of the standards for significant deterioration?

Whether future growth will result in a violation of the standards for significant deterioration will depend not only on the SIP, the class in which the subarea is located, but also the local growth patterns and the sources of the emissions. The significant deterioration regulations apply only to 19 specific sources, and in particular to SO_2 emissions and particulate matter from these sources. Even though air quality maintenance regulations are designed to maintain air quality areas at a level superior to the NAAQS's, it is conceivable that future growth and development (exclusive of the 19 sources) could have emissions which would "use up" the increment associated with the classification of the subarea, thereby precluding any future development of these 19 sources in the area.

Since the development of an air pollution control strategy designed to attain and maintain the NAAQS requires an analysis of current and possible future air quality problems, a series of publications have been designed to provide guidance in the development of an analysis conforming to the requirements of the current federal regulations. (50,54,55) These should be used as source documents to determine the impact of development, with and without the proposed wastewater treatment facility, on the quality of the air.

3.2.4 Third-Level Approach

The field of modeling in air pollution is fairly well advanced. For the modeling of some emissions, specific models are recommended. The application of atmospheric simulation models to AQMAs is discussed in Vol. 12 of the Guidelines for Designation of Air Quality Maintenance Areas (50); models discussed in this volume include modified rollback, Miller-Holzworth, Hanna-Gifford, HIWAY, APRAC-IA, AQDM, CDM, the Sampled Chronological Input Model and the SAI photochemical model.

Under the new regulations for projecting air quality concentrations of particulate matter and sulfur dioxide, the Air Quality Display Model (AQDM) or an equivalent model is required, unless an alternative is permitted. (52) Since AQDM and similar models yield long-term concentrations (seasonal or annual), States must apply a model to relate the long-term concentrations to short-term concentrations. (52) The recommended model for obtaining short-term concentrations for the general urban area is that of Larsen. (56) These and other required models may be determined by reference to the proper regulations and the Guidelines. There are many private firms and states which have these models "on line."

3.3 Noise Impacts

At present, there is no single universally accepted method of projecting community noise exposure from all sources. Most attempts to formulate an integrated approach have been directed either at evaluating individual building sites (57) or at formulating national policy. (58) Those projection methods useful for regional planning typically relate to a specific noise source (e.g., aircraft), and treat other sources as background. The method used here attempts to integrate these different approaches into a single impact forecast.

Development tends to increase people's exposure to noise primarily by bringing them close to existing noise sources such as highways and air corridors. It is not sufficient, however, simply to project population changes around each source. We must also take into account future changes in the noise levels themselves which will occur as noise sources grow and as new ones come into being. The procedure we must follow, therefore, is to compare:

a) the existing population's exposure to present noise levels with

b) the future population's exposure to projected noise levels.

The purpose of this section is to provide a step-by-step method for making this comparison. Since the subject of population projections has been addressed in detail in Chapter 2 above, most of the discussion in this section talks about projecting noise levels and estimating total community exposure.

The following discussion is divided into four sections. The first consists of an introduction to community noise, including relevant regulations, important noise sources, units in which noise levels are measured and manipulated, and the common indicators of community noise impact. The other sections describe three impact assessment techniques at different levels of complexity, and the conditions under which each should be used.

3.3.1 Introduction to Community Noise

Noise has come to be recognized as one of the most important environmental problems in an urban area, particularly since the passage of the Noise Control Act of 1972.

> Historical evidence shows that excessive noise has long been considered a menace to the public health and welfare. Over the past two centuries industrial development has resulted in a steady increase in the extent of noise impact.
>
> Noise can affect the ability to communicate or to understand speech and other signals. This may arise from either actual impairment of the hearing mechanism or as a result of intrusions of sounds such that the desired ones cannot be understood by the listener. (59)

Other adverse effects include loss of sleep, interference with activities, and general loss of amenity termed "quietness."

Numerous agencies at all governmental levels have issued or are in the process of issuing regulations regarding the design and operation of noisy equipment and setting allowable levels of noise emissions (see below). In addition, public works projects are being increasingly subjected to scrutiny, and in some cases litigation, from interested parties concerned with noise emissions (see, for example, Tiber Island Condominium, et al. v. Washington Metropolitan Area Transit Authority). (60) It is clearly in the interests of both the community and the developer that noise be considered in the earliest stages of the planning process.

At present, there are two Federal noise regulations of direct interest to land use planners. These are:

- Federal Highway Administration FHPM 7-7-3. (61) Issued in 1976, it sets noise guidelines for all Federally aided highway construction and expansion.
- HUD Circular 1390.2 (62) Sets noise exposure guidelines for construction of housing assisted by HUD funding.

In addition, the EPA has specified noise levels "requisite to protect public health and welfare with an adequate margin of safety." (63) These specifications do not have the force of law, but they could serve as the basis for community action against overly noisy projects. Some of the provisions of the above standards are discussed below where appropriate. A complete listing of Federal Noise control activities and regulations has been published. (64)

In addition to Federal standards, many states and municipalities also have noise ordinances. These should be obtained from the relevant agencies and considered in the planning process. A summary of such ordinances as they existed in 1973 has been published by the EPA. (65)

For purposes of this manual we can identify four categories of noise sources in the urban environment. These are:

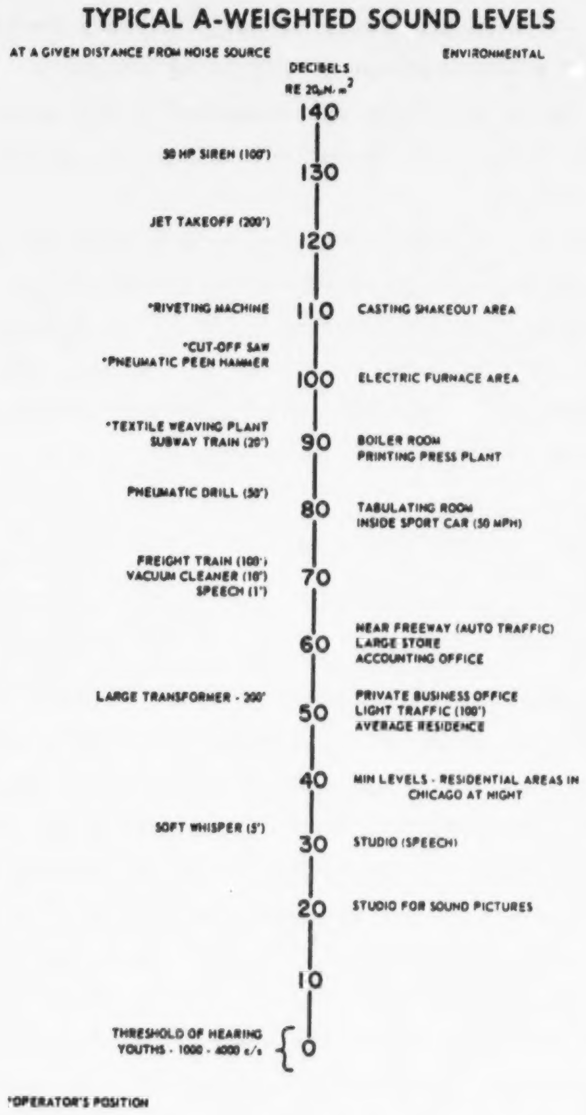
- highway traffic
- aircraft
- railroads
- urban activity

This last is a composite category which includes a number of types of noise generated simply by the presence of an urban environment (street traffic, construction, industrial activity, and other operated equipment).

Noise levels are commonly expressed in units of "A-weighted" decibels (abbreviated, "dB(A)"), a measure of sound intensity which is weighted to simulate the variation of the ear's sensitivity with frequency. For most noises the level decreases with distance from the source; therefore, the characteristic noise level of a particular source (e.g., a truck) is typically expressed in terms of dB(A) at a stated "reference" distance. Figure 3.8 shows the A-weighted noise levels produced by some common sources. (66) Because noise levels are computed logarithmically, they do not add in the conventional manner. A convenient method for adding decibel levels is shown in Figure 3.9. (66)

People react not just to noise levels alone but also to the number of noisy events, the duration of each event, and the time of day in which the event occurs. Some noise sources have relatively low, constant levels (e.g., street traffic), whereas others, such as aircraft, may be relatively infrequent but of high intensity. Numerous attempts have been made to come

Figure 3.8



Source: Handbook of Noise Measurement (66) up with an index that takes into account the variability of noise as well as its level. These indices are usually expressed in terms of a dB(A) level which is modified to include the variability of the effects mentioned above. For reasons as much historical as technical, different indices have come to be associated with particular noises. We shall briefly review the commonly used indices of noise impact according to the sources listed above. Then we will define a single index which should be used for the purposes of the manual and describe how to relate the other indices to it.

Figure 3.9

Approximate Addition of
Noise Levels

Difference Between Two Noise Levels	Add to the Higher of the Two
1 dB or less	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

Highway traffic. Noise from highway traffic (trucks and automobiles) has usually been expressed in terms of the statistical distribution of A-weighted noise levels. Typical indices are L_{50}, the noise level which is exceeded 50% of the time, and L_{10}, the level which is exceeded 10% of the time. Figure 3.10 shows the highway design noise levels presently enforced by the Federal Highway Administration. (67) These noise levels for different land uses are expressed in terms of the maximum allowable hourly L_{10} and L_{eq}, which measures the time-averaged dB(A) level. (L_{eq} is explained further under "Urban Activity" below).

Aircraft. Because aircraft noise tends to be intermittent, indices related to it have emphasized the frequency and duration of flyovers as well as the noise produced by each flyover. The most commonly used noise descrip-

FIGURE 3.10

DESIGN NOISE LEVEL/LAND USE RELATIONSHIPS

ADOPTED BY FHWA

Activity Category	*Design Noise Levels - dBA*[1] L_{eq} *(h)*	 l_{10} *(h)*	*Description of Activity Category*
A *3/*	*57* *(Exterior)*	*60* *(Exterior)*	*Tracts of land where serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, open spaces, or historic districts which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.*
B[2]	*67* *(Exterior)*	*70* *(Exterior)*	*Picnic areas, recreation areas, playgrounds, active sports areas, and parks which are not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries and hospitals.*
C	*72* *(Exterior)*	*75* *(Exterior)*	*Developed lands, properties or activities not included in Categories A or B above.*
D	--	--	*For requirements on undeveloped lands see paragraphs 11a and c.*
E[3]	*52* *(Interior)*	*55* *(Interior)*	*Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.*

---

[1] *Either* L_{10} *or* L_{eq} *(but not both) design noise levels may be used on a project.*

[2] *Parks in Categories A and B include all such lands (public or private) which are actually used as parks as well as those public lands officially set aside or designated by a governmental agency as parks on the date of public knowledge of the proposed highway project.*

[3] *See paragraphs 8c, d, and e for method of application.*

Source: Federal Highway Administration, Federal Highway Program Manual (67).

tor has been the Noise Exposure Forecast (NEF), a decibel quantity which measures the noise for each flyover in terms of a unit called the Tone Corrected Perceived Noise Level (a measure similar in purpose to the A-weighted level but derived differently) and which adds correction terms for the duration of each event, the number of events, and the time of day (0 dB for daytime, 12 dB for nighttime [10 p.m. to 7 a.m.]). Figure 3.11 shows the NEF land use rating system suggested by the U.S. Department of Housing and Urban Development. These NEF values can be converted to Day-Night Equivalent Noise Levels (L_{dn}) using the procedure developed in Section 3.3.2. The U.S. Environmental Protection Agency has encouraged the use of L_{dn} noise descriptor for all environmental noise sources, including aircraft, and has prepared a document which permits the computation of L_{dn} contours by hand. (69)

Railroads. Noise from railroads has received relatively little attention compared to the two sources discussed above, largely because attempts to regulate railroad noise are relatively recent. The two sources (70) (71) which treat community exposure to rail noise in terms of overall impact use the Day-Night Equivalent Noise Level (L_{dn}), an index which is discussed below.

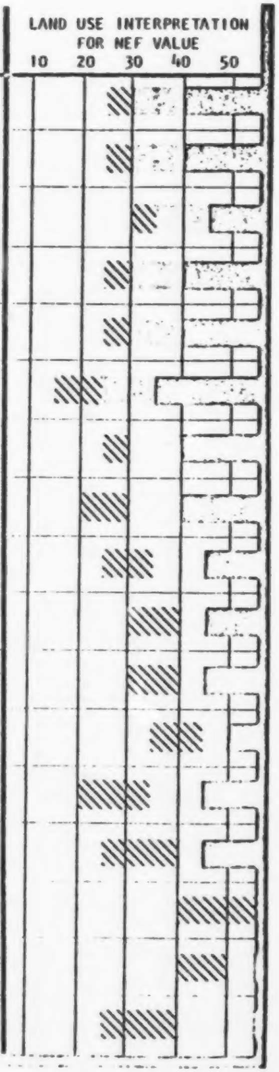
Urban activity. As we mentioned previously, "urban activity" is a catch-all for a group of sources which have comparatively low individual noise levels, are distributed fairly uniformly over urban areas, and, therefore, have a large cumulative noise impact. The EPA, which has primary responsibility for regulating such sources, has concluded that their impact is best measured in terms of L_{eq}, the equivalent of A-weighted sound level. (72) L_{eq} represents the steady-state sound level which would contain the same acoustic energy as the actual time-varying level when measured over a specified period. When the measurement period is 24 hours, the equivalent sound level is written as "$L_{eq}(24)$". This is the impact measure which the EPA feels is most meaningful when people's health and welfare are concerned. When noise interference with speech, sleep, and other activities is the problem, the EPA uses the Day-Night Equivalent Noise Level (L_{dn}). This is defined as the A-weighted average sound level during a 24-hour period with a 10 dB penalty added to nighttime (10 P.M. - 7 A.M.) noise levels.

The EPA does not restrict the use of L_{dn} to "urban activity" noises, but uses it to characterize the total community exposure to noise from all sources. Figure 3.12 shows the levels which EPA has established as desir-

Figure 3.11 LAND USE RATING SYSTEM SUGGESTED BY HUD

LAND USE COMPATIBILITY GUIDELINES FOR
AIRCRAFT NOISE ENVIRONMENTS

LAND USE CATEGORY	SLUCM[1] CODE	NSC[2]
Residential - Single Family, Duplex, Mobile Homes	11x[3]	1
Residential - Multiple Family, Dormitories, etc.	11x, 12, 13, 19	1
Transient Lodging	15	2
School classrooms, Libraries, Churches	68 7111	1
Hospitals, Nursing Homes	651	1
Auditoriums, Concert Halls, Music Shells	721	1
Sports Arenas, Outdoor Spectator Sports	722	1
Playgrounds, Neighborhood Parks	761, 762	1
Golf Courses, Riding Stables, Water Rec., Cemeteries	741x, 743x, 744	2
Office Buildings, Personal, Business and Professional	61, 62, 63, 69, 65[4]	3
Commercial - Retail, Movie Theaters, Restaurants	53, 54, 56, 57, 59	3
Commercial - Wholesale, Some Retail, Ind., Mfg., Util.	51, 52, 64, 2, 3, 4	4
Manufacturing, Communications (Noise Sensitive)	35, 47	2
Livestock Farming, Animal Breeding	815, 816, 817	3
Agriculture (except Livestock), Mining, Fishing	81, 82, 83, 84,85,91,9	5
Public Right-of-Way	45	5
Extensive Natural Recreation Areas	91, 92, 93, 99,7491,75	3



NOTES :

☐ Clearly Acceptable ▨ Normally Acceptable ░ Normally Unacceptable ▒ Clearly Unacceptable

Clearly acceptable: The noise exposure is such that the activities associated with the land use may be carried out with essentially no interference from aircraft noise. (Residential areas: both indoor and outdoor noise environments are pleasant.)

Normally acceptable: The noise exposure is great enough to be of some concern, but common building constructions will make the indoor environment acceptable, even for sleeping quarters. (Residential areas: the outdoor environment will be reasonably pleasant for recreation and play.)

Normally unacceptable: The noise exposure is significantly more severe so that unusual and costly building constructions are necessary to ensure adequate performance of activities. (Residential areas: barriers must be erected between the site and prominent noise sources to make the outdoor environment tolerable.)

Clearly unacceptable: The noise exposure at the site is so severe that construction costs to make the indoor environment acceptable for performance of activities would be prohibitive. (Residential areas: the outdoor environment would be intolerable for normal residential use.)

[1] Standard Land Use Coding Manual.

[2] Noise Sensitivity Code (see page 53).

[3] x represents SLUCM category broader or narrower than, but generally inclusive of, the category described.

[4] Excluding hospitals.

Source: Department of Housing and Urban Development, Aircraft Noise Impact - Planning Guidelines for Local Agencies. (68)

Reproduced from best available copy.

Figure 3.12

YEARLY AVERAGE* EQUIVALENT SOUND LEVELS IDENTIFIED BY EPA AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

		Indoor			Outdoor		
	Measure	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)(d)}$	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)(d)}$		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity. (See Figure D-2 for noise levels as a function of distance which allow satisfactory communication.)

b. Based on lowest level.

c. Based only on hearing loss.

d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years.

*Refers to energy rather than arithmetic averages.

Source: U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin. (72)

able for various community purposes. (72) Our concern here is with the social impacts of noise; we shall therefore adopt L_{dn} as our index of noise impact.

The use of L_{dn} to characterize noise from a variety of sources is becoming increasingly widespread. The Federal Aviation Administration, for example, has issued procedures for direct computation of L_{dn} contours from general aviation airports. (73) This trend is expected to accelerate; at present, however, much of the noise literature relevant to regional planning employs a variety of uncommensurable indices. The next section therefore gives procedures for obtaining estimates of L_{dn} where noise levels are given in other units.

3.3.2 Converting Impact Measures to L_{dn}

Because the various impact measures each take into account different properties of noise, there is no totally accurate way to convert from one measure to another. The EPA, however, has established procedures which produce minimal error in most cases. (74) To convert aircraft noise impacts (usually expressed in terms of NEF or CNEL) to L_{dn}, use the expression

$$L_{dn} \simeq \text{CNEL} \simeq \text{NEF} + 35 \qquad (1)^*$$

To obtain L_{dn} for highway noise, several conversion techniques are available depending on what noise measure one is starting with. In all of the expressions below, "day" is defined as the period between 7 A.M. and 10 P.M.

Converting from $L_{eq}(h)$ to L_{dn}

$L_{eq}(h)$ represents L_{eq} during the design or peak traffic hour. Use the expression

$$L_{dn} = L_{eq}(h) + A \qquad (2)$$

where A is a correction factor which depends on the percentage of traffic (expressed in terms of total vehicles) carried during the day, i.e., percentage total day traffic is of the total traffic during the 24 hour period. Values of A are given in Figure 3.13.

---

*Equation (1) is accurate to within ± 3 dB.

Figure 3.13

Correction Factor for Converting $L_{eq}(h)$ to L_{dn}
For Highway Noise (75)

% Vehicles Carried During the Day 7 a.m.-10 p.m. of Total 24 Hour Period	A(dB)
62.5	3
75	2
85	1
90	0
95	-1
100	-3

Converting From $L_{10}(h)$ to L_{dn}

$L_{10}(h)$ represents L_{10} during the design or peak traffic hour. Convert $L_{10}(h)$ to $L_{eq}(h)$ using the expression

$$L_{eq}(h) = L_{10}(h) - 2dB$$

Then convert $L_{eq}(h)$ to L_{dn} using equation (2) above.

Converting From $L_{eq}(24)$ to L_{dn}

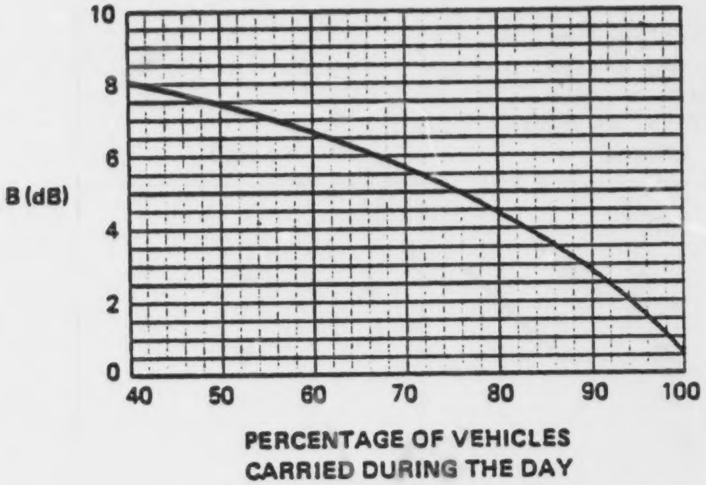
$L_{eq}(24)$ represents L_{eq} averaged over a 24-hour period (see above). Use the expression

$$L_{dn} = L_{eq}(24) + B \qquad (3)$$

where B is a correction factor which depends on the percentage of traffic (expressed in terms of total vehicles) carried during the day (day traffic compared to that carried during the 24 hour period). Values of B are given in Figure 3.14.

Figure 3.14

Correction Factor for Converting L_{eq} (24) to L_{dn} for Highway Noise



Converting From L_{eq}(day) and L_{eq}(night) to L_{dn}

Use the expression

$$L_{dn} = L_{eq}(\text{day}) + C \tag{4}$$

where C is a correction factor which depends on the value of $L_{eq}(\text{day}) - L_{eq}(\text{night})$. Values of C are given in Figure 3.15.

Converting From L_{10}(day) and L_{10}(night) to L_{dn}

Convert L_{10}(day) to L_{eq}(day) and L_{10}(night) to L_{eq}(night) using the expressions

$$L_{eq}(\text{day}) = L_{10}(\text{day}) - 2\text{dB and}$$

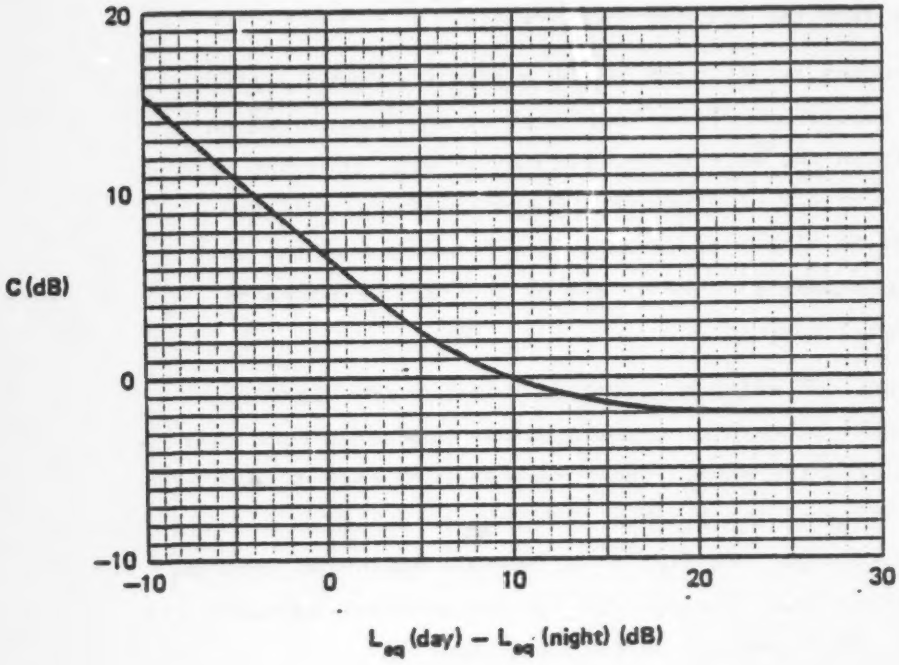
$$L_{eq}(\text{night}) = L_{10}(\text{night}) - 2\text{dB}$$

respectively. Then use Equation (4) to obtain L_{dn}.

Figure 3.15

Correction Factor for Converting

L_{eq}(day) and L_{eq}(night) to L_{dn} for Highway Noise



3.3.3 First-Level Approach

Noise from Aircraft Operations

(1) Determine (a) whether there are any commercial or military airports in the subarea or within 15 miles of the boundaries of the subarea, or (b) whether there are any plans or proposals for airport construction. If the answer to both questions is "no," proceed to the First-Level Approach for Highways (below). If the answer to question (a) only is "yes," proceed to the next step. If the answer to question (b) only, or to both (a) and (b), if "yes," proceed to the Second-Level Approach.

(2) On a map, draw a border around each existing airport according to the following rules (see Figure 3.16).

--along each major flight route, draw a corridor 10 miles long and 1 mile wide

--in every other direction, draw a border 2 miles from the airport boundary line.

Determine whether a) any part of the analysis subarea falls within this border and b) for that part of the subarea which does fall within the border, the population will increase more than 10% as a result of constructing the treatment facility. If the answer to either a) or b) is "no," proceed to the next step. If the answer to both a) and b) is "yes," proceed to the Second-Level Approach.

(3) Determine, for existing airports, whether any significant changes in their pattern of operations are projected such that noise levels will increase. Such changes could include a change in the proportion of jet flights, a change in the distribution of flights between night and day, or an overall expansion program. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the next step.

(4) Determine from the airport management, the FAA, or other appropriate agency whether the projected change over the next 20 years in the number of flights per day will be more than 50% of the present number. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the First-Level Approach for Highways (below).

Noise from Highways

(1) Determine a) whether there are any existing or planned highways within one mile of the boundaries of the project subarea or b) whether there are any plans or proposals for such highways. If the answer to both questions is "no," proceed to the First-Level Approach for Railroads (below). If the answer to question a) only is "yes," proceed to the next step. If the answer to question b) only, or to both a) and b), is "yes," proceed to the Second-Level Approach.

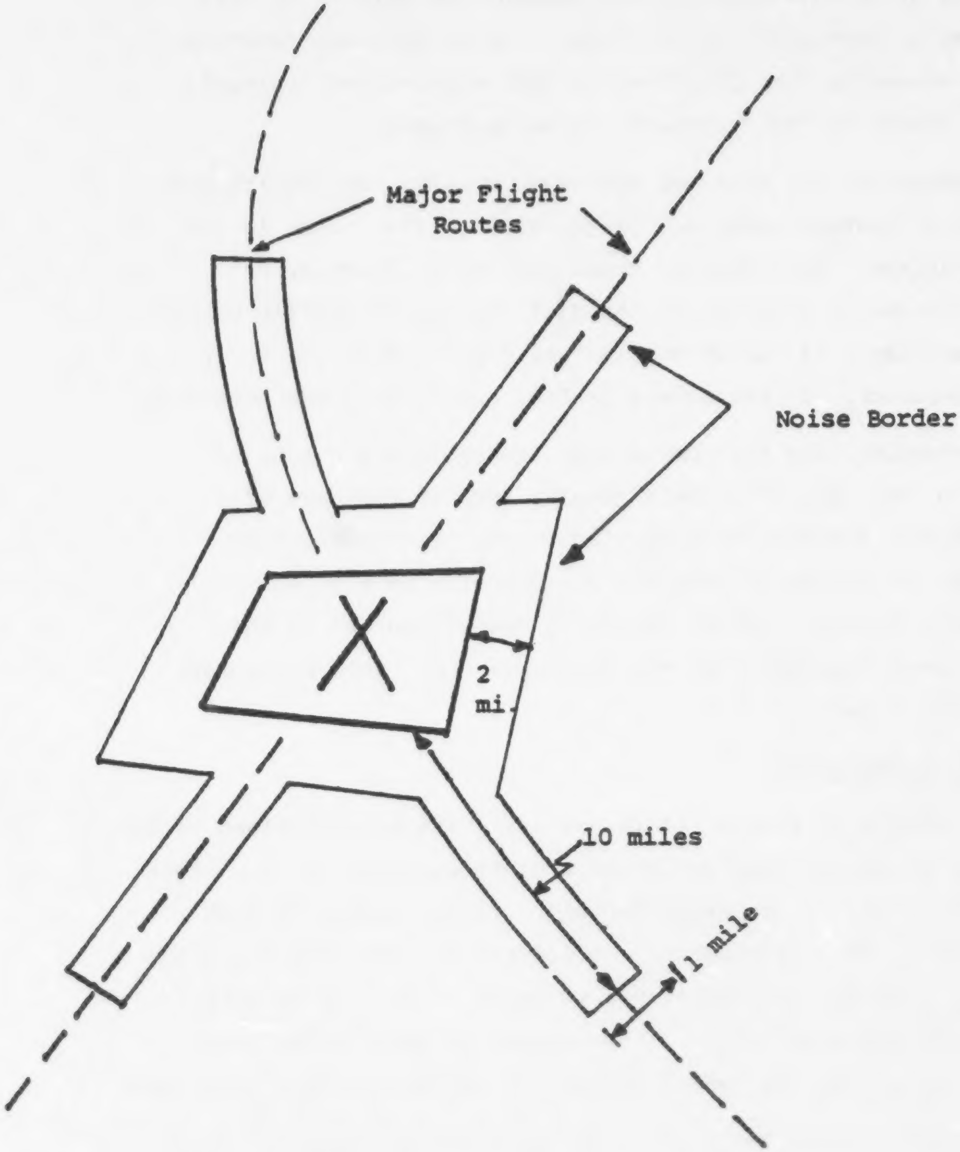


Figure 3.16

Illustration of How to Construct Noise Border for First Level Estimation of Aircraft Noise Impacts

(2) Determine, for those parts of the subarea which lie within one mile of an existing highway, whether the population will increase by more than 10% as a result of project construction. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the next step.

(3) Determine, for existing highways, whether any significant changes in highway usage are projected such that noise levels will increase. Such changes could include an increase in truck traffic or a change in the distribution of traffic between night and day. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the next step.

(4) Determine, for the appropriate agency (State Bureau of Roads, in the case of state highways; FHWA in the case of Interstates) whether the projected change over the next 20 years in the number of vehicles per day will be more than 50% of present levels. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," ignore highways as a noise source.

Noise from Railroads

(1) Determine a) whether there are any existing rail lines within one mile of the boundaries of the project subarea, or b) whether there are plans or proposals for any. If the answer to both questions is "no," proceed to the First-Level Approach for Urban Activity (below). If the answer to question a) only is "yes," proceed to the next step. If the answer to question b) only, or to both a) and b), is "yes," proceed to the Second-Level Approach.

(2) Determine, for those parts of the subarea within one mile of an existing rail line, whether the population will increase by more than 10% as a result of project construction. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the next step.

(3) Determine whether any significant changes in the pattern of operations are projected, such that noise levels will increase. Significant changes include a change in the distribution of traffic

between passenger and freight or between night and day; a change in average train speed; or a change in the average number of cars per train. This information may be obtained from the railroad or rail transit system which operates the line. If the answer is "yes," proceed up the Second-Level Approach.

(4) Determine, from the operator of the line, whether the projected change over the next 20 years in the number of trains per day will be more than ± 50% of present levels. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," proceed to the First-Level Approach for Urban Activity (below).

Noise from Urban Activity

(1) Determine a) whether there are any existing or planned industrial sites which have exposed machinery and which are within ¼-mile of residences, or b) whether any such sites are planned. If the answer to either a) or b) is "yes," proceed to the Second-Level Approach. If the answer to both is "no," proceed to the next step. (Note that zoning ordinances can provide a guide as to the future likelihood of such developments.)

(2) Determine from with-sewer development projections made in Chapter 2 whether the projected 20-year change in population density at any point within the subarea averaged over a square mile, will exceed ± 50% of its present value. If the answer is "yes," proceed to the Second-Level Approach. If the answer is "no," then there is not likely to be any significant increase in community noise exposure as a result of the sewer development.

3.3.4 Second-Level Approach

If the approach outlined above shows that any one of the four noise source categories may present a problem, then the entire noise situation must be examined in some detail. Unfortunately, there are no "quick-and-easy" methods for obtaining projections of community noise impact; each source must be analyzed separately and combined with other sources and with alternative population distributions. Because of the highly technical nature of the subject matter, it is recommended that the planner or developer obtain the services of an individual or organization which is professionally qualified to perform community noise studies. Such a consultant will be able to assist not only by predicting noise impacts but also by suggesting planning and design features to minimize problems where they occur. The following discussion will not replace such services, but it will act as a guide to the planner in analyzing the nature of the specific problem at hand, in describing the problem to the consultant, and in evaluating the quality of the consultant's work.

The object of the procedure described below is to obtain a graph or table showing, for each level of L_{dn}, how many people in the service area of the project would be exposed to that level or higher. The difference between this population distribution as projected with and without development is a direct measure of the effect of development on community noise exposure. The approach is divided into three steps: 1) establishing current noise levels; 2) projecting noise levels with and without development; and 3) obtaining the distribution of people exposed to different noise levels with and without development.

(1) Establishing Current Noise Levels

Before noise levels can be projected, the current situation must be defined. In particular, one must determine how much noise is coming from each of the four source categories, even if some of those categories were determined not to be a problem under the First-Level Approach.

It is possible that noise surveys may already exist for the area in question, particularly if any large public works projects (highways, airport expansion, etc.) had been undertaken in the vicinity in the last few years. Queries should be made with the Regional Office of EPA, the State Bureau of Roads, the FAA, state environmental affairs offices, and similar organizations having responsibility for environmental matters.

To the extent that such existing information fails to account for any of the important source categories or is out of date, an independent survey should be undertaken. The Department of Transportation has sponsored development of plans for conducting community noise surveys. A detailed method, along with cost estimates, has been described in a report. (76) The method described therein allows for very complete sampling of a large number of noise situations, so that the contribution of each major source category can be identified (it is also rather expensive). A noise consultant can adapt the DOT procedure to the particular circumstances at hand, and can thereby save money and effort at some expense in completeness and precision. There are several examples of such limited but still useful survey techniques. (77) In addition, EPA is presently developing a manual to assist in conducting community noise surveys.

Whatever the source of the data, the resulting product should consist of a) a set of area maps showing contours of L_{dn} for each source category (aircraft, highways, etc.) by itself, and b) a single subarea map showing contours of total L_{dn} for all source categories taken together. If existing noise surveys are used, they may report their results in terms of an index other than L_{dn}. In that case, the rules given in equations (1) through (4) can be used to transform the reported index into values of L_{dn}. To convert the individual maps of L_{dn} for each source category into a single composite map, the maps should be overlaid and the L_{dn} values from each map should be added for each geographical location according to the rules previously given. The resulting summed levels can be plotted on a new map, and contours of total L_{dn} may be drawn through the points.

(2) Project Future Noise Levels

Over a 20-year planning horizon, noise levels can be expected to change whether a particular development project is undertaken or not. To obtain proposed development impact, noise levels both in the absence of and in the presence of the proposed project must be projected. The projection techniques are the same in both cases; only the data differ. To make a projection assuming no development it is necessary to use the composite map of the subarea (developed in Chapter 2) as it will look at the proper future date, showing all public works (highways, airports, etc.), and the population distribution which will occur under normal development pressures (e.g., without construction of the sewer project). The composite map with the project will show the induced effects of the project on the distribution of economic activities and population. Note that if a particular source category has already been determined in the First-Level Approach to have negligible projected growth, its noise impact need not be projected here. The current noise impact map for that category, as determined in Step 1 above, can be used in place of a projection.

We now present suggested projection techniques for each noise source category. In each case, the object of the procedure is to develop a map of projected L_{dn} contours for the service area.

Aircraft

Projections of noise levels for many commercial airports are available from the FAA and other sources. (78) For those airports not so covered, an EPA publication provides a simplified set of procedures for constructing the required contours. (69) Of course, it is necessary to have information regarding the probable level of activity at the airport in question for the time period for which one is projecting. If this is not available as far into the future as is necessary, reasonable assumptions should be made (and documented) based upon the best data available. Since most projections are stated in terms of NEF, it will be necessary to convert to L_{dn} units using Equation (1). A recent FAA report gives techniques for estimating L_{dn} contours directly. (79)

Highways

For highways already in existence, the present noise levels (as determined in Step 1 above) can be adjusted for future changes in traffic flows using the procedures outlined in National Cooperative Highway Research Program Report Number 117. (80) For highways which exist only conceptually as part of a future development plan, contours of L_{10} may be drawn by assuming that FHWA guidelines will be observed. (See Figure 3.10) This will set the position of the L_{10} = 70 dB (A) cotour relative to residential areas. The other contours can then be constructed using the procedures in NCHRP

Report 117. (80) Contours of L_{10} can be converted to L_{dn} using Equations (2) and (3). An alternative procedure which will soon be published by EPA gives results directly in terms of L_{dn}. (81)

Railroads

There are few, if any, site-specific projections of railroad noise available; nor are there any officially endorsed techniques for generating them. The most accurate method to date is that of EPA. (70) The simplest is that of Swing. (71)

Urban Activity

There are no standard procedures for estimating the change in noise level from urban activity. To attempt to project the noise from each individual street, lawnmower, industrial fan, etc. is not recommended except in cases where impact might be unusually severe. (Such a severe use might include increased population--never an existing or proposed industrial site. Such cases should be analyzed separately by specialists in noise control.) A general estimate of future levels can be obtained, however, by using the following empirical relationship: (82)

$$\Delta L_{dn} = 10 \log_{10} (\rho/\rho_o)$$

where ΔL_{dn} is the change in L_{dn} due to urban activity as measured in Step 1 above; ρ_o is the present population density at a given point; and ρ is the projected population density at the same point. The practical effect of this relationship is that, for every factor-of-two increase (or decrease) in population density, L_{dn} from this source goes up (or down) by 3 dB. By using this technique for a representative sample of points in the site, an array of point-estimates of L_{dn} will be obtained through which contours can be drawn.

Total Projected Noise Impact

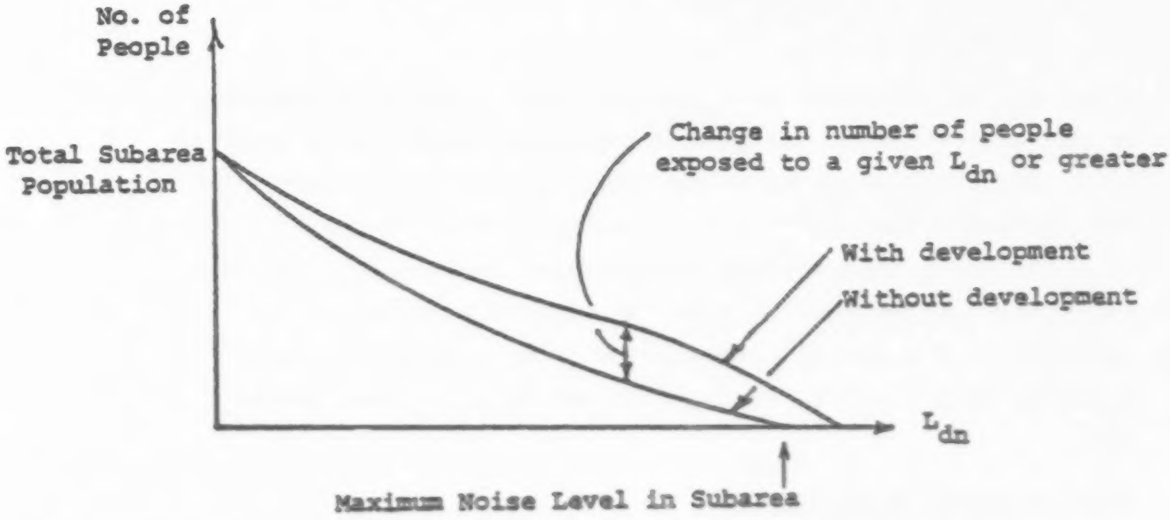
Once the subarea maps showning L_{dn} contours for the individual source category have been generated, they should be combined, using the procedure outlined at the end of Step 1 above, to obtain a map of total projected L_{dn} from all sources. This entire projection procedure will be repeated for the "with-" and "without-development" cases.

(3) Determine Population Distribution vs. Impact Level

Take the map of L_{dn} contours for the "without-project" case, as generated in Step 2 and overlay it on the map of projected "without-project" population density as generated in Chapter 2. Use this combined plot to obtain a graph showing, on its horizontal axis, L_{dn} and, on its vertical axis, the number of people exposed to a given level of L_{dn} or greater (see Figure 3.17 for an example). Repeat this procedure using the contour maps of total L_{dn} and population density for the "with-development" projection. The two curves of population vs. L_{dn} for the two projections should be plotted on the same graph. Visual comparison of the two curves gives the change in noise impact due to the development. If a single-number index of impact is desired, the best measure is the change in the number of people exposed to L_{dn} = 55 or higher; this may be read directly from the graph.*

Figure 3.17

Day-Night Equivalent Noise Level (L_{dn})



---

*An alternative index of noise impact is the Fractional Impact Method (FIM) presently being developed by the EPA and other noise research organizations. The FIM is a way of weighting the population-vs.-L_{dn} curve to give the equivalent number of people who are exposed to L_{dn} = 75. The method is currently undergoing revision; users of this manual should consult the EPA as to when a final version will be available.

Another acceptable procedure would be to draw histograms or distributions of the people exposed within five decibel increments of L_{dn}. Two histograms should be drawn, corresponding to the with- and without-development cases.

3.3.5 Third-Level Approach

The Second-Level Approach can be substantially improved by the use of computerized noise projection techniques. The role of these computer programs is to automate the "projection" portion (Step 2) of the Second-Level Approach. The output will consist of maps of noise level contours for individual source categories. The planner or his consultant will still have to construct composite maps of total L_{dn} with and without the project, as was described in Steps 2 and 3 of the Second-Level Approach.

Computerized projection models are available for two of the source categories: aircraft and highways.

Aircraft

The U.S. Department of Transportation's Office of Noise Abatement has sponsored the development of models which predict NEF contours for airports. (83,84)

Highways

Development of models to predict highway noise has been sponsored by the FHWA and other agencies. Analysis techniques, including those developed in NCHRP, have been assembled and modeled. (85,86)

3.4 Solid Waste Impacts

Problems associated with increasing urban solid waste volume (87) are exacerbated by the spreading out of population growth. Given adequate management of the solid waste collection system (88), costs increase with the extent of the area over which wastes have to be collected as well as with increased volume. Conversely, as population per acre increases, collection costs per acre are less because any factors which reduce labor time per unit waste collected and per capita generation will reduce costs. (89) This relationship between quantity, costs of collection, and spatial distribution of population is shown in Figure 3.18, Figure 3.19, and Figure 3.20. (90)

Figure 3.18

MUNICIPAL SOLID WASTES COLLECTION RATES

pounds/capita/day

Population	Waste Collection by Population Density Ranges		
r	0-3,999/sq.mi.	4,000-6,999/sq.mi.	7,000+/sq.mi.
0 - 4,999	3.3	-	-
5,000-19,999	3.6	5.0	4.6
20,000-99,999	4.1	4.1	4.6
100,000	4.6	5.1	5.6

Sources: Land Use, Urban Form and Environmental Quality (90)

Figure 3.19

SOLID WASTE GENERATION BY DWELLING TYPE

	Single Family	Multifamily	Apartment House
Pounds/capita/week	12.54	9.83	6.91
Gallons/capita/week	14.07	11.00	5.61
Pounds/cubic yard	179.97	180.50	248.87

Sources: Land Use, Urban Form and Environmental Quality (90)

Figure 3.20

SOLID WASTE GENERATION RATES BY DWELLING TYPE

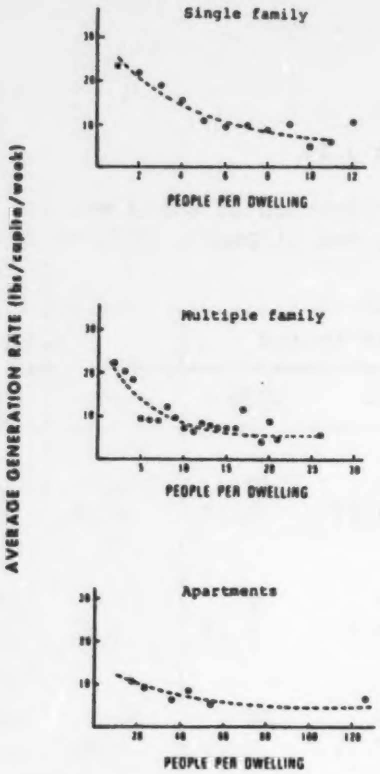


Figure 3.21 shows the total wastes generated by households and other municipal sources on a yearly basis. (90) National data is presented for familiarization but can be used if no better data are available.

Figure 3.21

ESTIMATES OF MUNICIPAL WASTES

Waste Source	Multipliers
Household Garbage and Rubbish	
Single Family Unit	1.42910 tons/unit/year
Multiple Family Unit	0.62755 tons/unit/year
City Streets: Leaves, Litter, Sweepings, and Tree Trimmings	42.9 lb/capita/year
Refuse Collected Along Highway Right-of-Way	
Freeway Refuse	8.0 tons/mile/year
County Roads Refuse	3.3 tons/mile/year
Sewage Treatment Residue	87.1 lb/capita/year
Local Parks and Playgrounds	5.4 lb/capita/year
Regional Parks	
TOTAL WASTE	

Reproduced from best available copy.

SOURCE: Land Use, Urban Form and Environmental Quality (90)

Recent estimates and projections of solid waste generation, resource recovery, and disposal, for the period 1971 to 1990, are shown in Figure 3.22. (91)

Figure 3.22

Baseline Estimates and Projection of Solid Waste Generation, Resource Recovery and Disposal, 1971 to 1990*

	Estimated		Projected		
	1971	1973	1980	1985	1990
Total gross discards:					
Million tons per year	133	144	175	201	225
Pounds per person per day	3.52	3.75	4.28	4.67	5.00
Less: resources recovered:					
Million tons per year	8	9	19	35	58
Pounds per person per day	0.21	0.23	0.46	0.81	1.29
Equals net waste disposed of:					
Million tons per year	125	135	156	166	167
Pounds per person per day	3.31	3.52	3.81	3.86	3.71

*For post consumer municipal solid wastes, which are defined as those discarded by the final consumer, not by raw-material producers and manufacturers.

Source: Resource Recovery and Waste Reduction, Third Report to Congress (91)

Waste generated by manufacturing concerns varies according to the materials utilized in the concerns' production processes. Figure 3.23 provides a method of estimating these wastes, given estimates of industrial employment.

Figure 3.23

ESTIMATES OF MANUFACTURING WASTES

Industry	Multipliers tons/employee/year
Seasonal Foods	5.56570
Other Foods	4.81655
Paper, Printing, and Publishing	12.87060
Chemicals	8.21075
Textiles and Apparel	.52575
Rubber and Plastics	1.54810
Leather	2.49365
Stone, Clay, Glass, and Concrete	18.11425
Primary and Fabricated Metals	6.7300
Electrical and Nonelectrical Machinery	3.58040
Lumber and Wood Products	21.68805
Furniture and Fixtures	20.15545
Transportation Equipment	3.39330
Instruments	2.51700

Source: Land Use, Urban Form and Environmental Quality (90)

Historically, landfill is the most common and cheapest method of solid waste disposal. The municipal open dump, where unprocessed refuse often proceeds severe problems of ground water pollution through leaching, loss of land value, fire dangers, and rodent infestation, is rapidly being phased out. The more acceptable sanitary landfill method reduces these threats but is often restricted because acceptable sites, when available, are usually located far from the urban center, making transportation costs high. The alternatives for extending the life of present landfills can also be expensive; they include: (92)

- to withdraw newsprint or other recyclable materials by a separate collection service or mechanical separation, thus reducing the volume 10 to 50%;
- to pile the refuse above the normal adjacent elevations, when design parameters allow, thus creating small hills which later can be landscaped;

- to compact the refuse into bales, thus increasing the density up to 1,800 pounds per cubic yard, approximately twice the density of conventional landfill;
- to shred, grind, pulverize or mill the refuse, often accompanied by ferrous extraction or energy recovery, extending the landfill life by 35 to 50%;
- to incinerate the waste before land filling, thus reducing the volume from 80 to 90%, but increasing costs due to air pollution standards which mean extremely costly stack gas cleaning systems; use as a fuel can reduce this cost.

Significant reuseable resources are contained in solid wastes. Solid waste can be also used as a source of energy. Even though demonstration programs have been beneficial in improving technology to a limited extent, not enough emphasis has been placed on developing methods of recovering natural resources from the waste of reuse (recycling) or on new or improved methods of disposal. (93) The recovery of valuable resources from waste has the potential of reducing the waste where it is generated, reducing cost and other problems associated with increasing energy consumption and natural resource depletion, and, most importantly, alleviating the problem of solid waste disposal. The recovery process is a complex technological one which will not be discussed here; the feasibility of the different methods are presently being tested through certain EPA-funded demonstration projects. (94) In summary, the solid waste impact of future growth in a subarea will depend upon the volumes being generated, waste characteristics, refuse disposal, and the plans made for its disposal.

3.4.1 First/Second-Level Approach

1. The first step is to determine the total volume of municipal solid wastes which will be generated in the project service area, by year, for the next 20 years. Separate estimates of the volume should be made with and without the proposed waste water treatment facilities. Local data should be used if available. If not, the analyst should first consult the above figures to determine the rate of overall municipal solid waste generation appropriate to the population size and density of the project service area. Waste generation rates should be adjusted upward for each successive year by a growth factor of approximately 3%, which reflects an increase in the rate of solid wastes per person. (91) Total municipal volumes for each

future year, with and without the project, can be calculated using the population projections done previously in Chapter 2 and data from the above figures.

This time series of estimated total municipal volumes can then be cross-checked by a separate set of calculations using the estimates of annual solid wastes generated by different types of dwelling units and urban activities displayed. Reference should be made to the composite land use maps developed in Chapter 2 for information in each case regarding the projected quantities of each land use type, with and without the waste water facility. Any major discrepancy between these two estimates of total projected municipal volumes (with and without the project) should be noted and reconciled.

2. A separate series of annual estimates, with and without the project, can be made for generation of industrial solid wastes in the service area, using the annual multipliers provided by type of industrial activity in Figure 3.26. Again, the projections of the levels of industrial activity in the service area with and without the project made in Chapter 2 can serve as the basis for making the annual calculations.

3. Adding the municipal and industrial totals together, the next step is to determine how this total amount of solid wastes will be disposed of over the next 20 years.

Although it is likely the method will be by landfill, alternative methods which are under investigation by local, regional and state authorities should be explored and a judgment made of their probable implementation. Where disposal will depend upon incineration, air pollution impact should be reevaluated by determining the probable discharge (this data is usually obtainable from the manufacturer of the equipment).

Evaluation of the disposal of waste by landfill will necessitate determining: (1) whether the landfill will be able to receive this volume, along with any other possible sources which utilize the same site; and (2) determining the environmental impact of the landfill on the environment. The volume of waste to be placed in the landfill can be calculated by dividing the weight of waste disposed each year over the twenty years by the density of the waste. The initial waste density can be estimated by assuming one of the following, depending on the disposal method used at the landfill:

(a) 700-900 pounds per cubic yard in a dump,

(b) 1200 pounds per cubic yard in a compacted landfill,

(c) 1800 pounds per cubic yard if compacted into bales before landfilling.

This calculation should be made in each case for the estimated quantities with and without the proposed WWTF.

The evaluation of the impact of the landfill on the environment may be done by comparing the existing operation of the site against accepted standards for the design and operation of landfills (95) or by using a specialized evaluation process. (96) An impact that should be carefully examined is whether the volume, with and without the proposed WWTF, can be handled at that site, and at what times the difference in projected volumes necessitate closing out the site.

4.0 SENSITIVE ENVIRONMENTAL AREAS

Sensitive environmental areas are defined as natural areas which are critical in the ecological cycle. In a comparatively small area, there is usually a complex environment supporting unique or diverse biological species which are bound by an ecological chain of interdependence.

The sensitive environmental areas examined in this section are primarily water oriented. Availability of water in wetlands, coastal areas, flood plains, and wildlife habitats is important because it may provide the necessary setting for breeding, sanctuary from predatory animals, and preservation of open space in its natural state. The growing scarcity of land and the increasing ability of man to move and shape environments further jeopardizes existing sensitive areas. Over 45 million areas of primitive marshes, swamps, and seasonally flooded bottomland have already succumbed to development pressures. (97) The necessity for controlling development is well documented. (98)

This chapter provides the analysis procedures necessary to determine what sensitive environmental areas will be impacted, the amount of impact, and the type of impact resulting from the WWTF. In addition, the chapter includes suggestions regarding ways to reduce these impacts through application of various regulations governing the use of sensitive areas.

The following sections describe the four types of sensitive environmental areas (wetlands, coastal areas, flood plains, and wildlife habitats) and suggest a single comprehensive approach for analysis of impacts on each type of sensitive area. Application of analysis approaches in a particular subarea will depend upon the number of sensitive environmental areas there are in the subarea, the proximity of these areas to the WWTF, and the size of the project. It is, therefore, likely that smaller WWTF projects will not require the same level of analysis of sensitive land impacts as larger projects.

4.1 Wetlands

Wetlands are those land and water areas subject to regular inundation by tidal, riverine or lacustrine flows. Wetlands generally include all inland and coastal shallows, marshes, mudflats, estuaries, swamps and similar areas in coastal inland navigable waters. Perhaps the single physical feature which best characterizes wetlands is the slow drainage of water from these areas.

Wetlands serve important purposes in the ecological cycle. In addition, they are places for recreation, and provide vistas of general aesthetic interests. As such, wetlands are considered to perform functions important to the public interest, including:

- support of biological functions, ranging from food chain production to general habitat for nesting, spawning, rearing, and resting sites for aquatic or land species;
- areas for study of the aquatic environment or as sanctuaries or refuges;
- part of the ecological system which regulates or controls natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, water current patterns and other associated environmental characteristics;
- valuable storage areas for storm and flood waters;
- prime natural recharge areas, where surface and ground water are directly interconnected.

One useful distinction which should be noted is the designation of protected areas based on "wetlands" or "shoreline." Shoreline regulations and resulting management programs do not depend upon the intrinsic value of natural qualities (i.e., wetlands) to define an affected area; the area which is protected under the regulation or act is defined by some absolute distance. Shoreline regulations therefore become a zoning tool for protecting a larger area, including that fragile part of the natural environment--the wetlands. (97)

The body of literature on wetlands (technical, political, theoretical, or practical) is limited. However, specialists in agriculture and conservation have studied wetlands for the basic role they serve as habitats for fish and wildlife. Scientists and laymen have recently recognized that the wetlands play a crucial role in the hydrologic cycle.

The largest gap in our knowledge of wetlands is the role they play in the natural water cycle. Due to the long length of time during which water is located over the wetland, there is a continuing opportunity for water to infiltrate into the ground. Whether this flows underground into aquifers, or remains to augment streams during low flows, depends upon local geology and is still the subject of research. However, it is presently recognized that wetlands, in conjunction with groundwater storage and aquifers, represent an ecosystem of unique and major importance to the nation and, as a result, merit extraordinary protection. (98)

It is estimated that comparable developmental forces would be expected to inflict more lasting damage to wetlands than to other ecosystems. Therefore, EPA has created appropriate safeguards for the preservation and protection of the wetland resources. In particular, it is EPA's policy to "minimize alteration in the quantity or quality of the natural flow of water that nourishes wetlands and to protect wetlands from adverse dredging or fill practices; solid waste management practices; siltation or the addition of pesticides, salts or toxic materials from nonpoint source wastes and construction activities; and to prevent the violations of applicable water quality standards from such environmental insults." (101)

One of the most destructive impacts on wetlands can occur through a dredge and fill operation. The potential for this to occur increases with the development potential of the wetland. Section 404 of the Federal Water Pollution Control Act provides for the exclusive Federal regulation of discharges of dredged or fill material in virtually all waters of the United States by the Secretary of the Army, acting through the Corps of Engineers. (In addition, the Corps of Engineers is responsible for a regulatory permit program for structures or dredge or fill activities in navigable waters under Secion 10 of the River and Harbor Act of 1899. Guidelines for issuing permits in navigable waters or oceans have been issued. (102,103) Permits which are issued under Section 404 are subject to review by EPA, which is authorized to "prohibit the specification of any defined area as a disposal site," and to "deny or restrict the use of any defined area for specification as a disposal site, whenever it is determined that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas." (104)

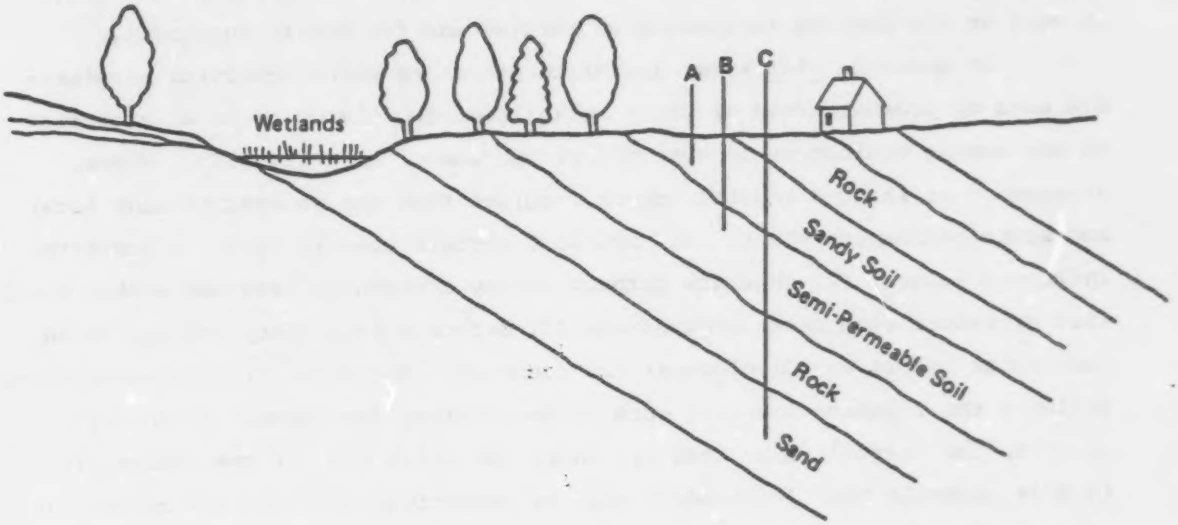
Even if local ordinances, state laws, or Federal laws prevent the destruction of wetland areas, severe impact on wetlands can result from induced urban development on adjacent land. For example, there may be a conflict between the mosquito population which inhabits a wetland and the comfort and safety of individuals who are locating on adjacent property. Man's attempt to control mosquitoes by aerial spraying, whether by DDT or malathion, may lead to an ecological imbalance, destroying the beneficial insects while only temporarily eliminating the mosquitoes in the wetlands. Draining or filling a wetland is clearly the most effective means of controlling mosquitoes; however, this approach would, at the same time, irreversibly eliminate the unique ecological contribution of the wetland area to an ecological cycle. Other impacts of man-made activities on wetland include storm water runoff which contain pollutants, noise from adjacent uses which destroys the wide range of wildlife inherent to that habitat, and wide fluctuations in water levels, thereby changing the plant life.

EPA's policy on wetlands includes prohibition of granting funds for the construction of municipal wastewater treatment facilities or other waste treatment-associated appurtenances which may interfere with the existing wetland ecosystem, except where no other alternative of lesser environmental dmaage is found to be feasible. Therefore, where there is any reason to believe that wetlands will be impacted, an assessment of secondary impact must identify the various alternatives which have been investigated, including the reasons for rejecting those alternatives not used. (101) The selection of the most environmentally protective alternative should be made. (106)

4.1.1 First/Second-Level Approach--Wetlands

Sections 2.2.1 to 2.2.4 provide alternatives to identify subareas which are likely to be subject to induced growth pressures. Comparison of the distribution of these impacted subareas with a map overlay showing the pattern of wetland location in these subareas will indicate the extent to which induced development will affect the wetlands. The analyst should be particularly sensitive to situations in which development pressures are likely to change wetlands from their natural state to other uses. The extent of this type of impact due to induced growth should be expressed in absolute terms (number of acres developed) and relative terms (percentage of total wetland developed).

The impact on water supply from the development of wetland is difficult to ascertain, unless the geology of the subarea has been studied. (The U.S. Geological Survey should be consulted to determine if this has been done.) If a survey has not been done, an index of potential impact on water supply may be constructed as follows. First, determine the number of wells in the subarea. If there are wells, impact on these wells will depend on whether water is replenished from wetlands. A rough estimate of well-water dependence on wetland waters may be developed by examining the depth and location of wells relative to wetlands. (Given the existence of USGS data, these water-bearing strata can be identified.) If wells are relatively shallow and located near wetlands, it is more likely that well replenishment depends on abutting wetlands. On the other hand, a wetland may recharge an underground source. For example, wells "A" and "B" in the following diagram would not be affected, whereas "C" would, due to the underlying geological characteristics of the area.



Sources of information on the number of wells, their depth, and their location include the local health department, local well-drillers, and state and local engineering societies where soil records are likely to be maintained on drilled wells.

4.2 Coastal Areas

The Coastal Zone is critical as an environmental area for a number of reasons. As the interface between land and water, this area is important because it is a fish and wildlife habitat, an essential link in the food chain and nutrient trap, and because it acts as buffers against storms and flooding. Salt marshes are indispensable as natural life-support systems. Many species of fin and shellfish and the birds that feed upon them are dependent during at least part of their life cycle on tidal marshlands. Coastal marsh areas are also highly productive sources of nutrients; animal populations can survive there largely because of the marshes' ability to convert sunlight and nutrients into organic material. Marsh production greatly exceeds that of most other natural ecosystems because frequent tidal flooding continually fertilizes all marshlands and removes metabolic wastes of the benthic algae and phytoplanton. Coastal areas contribute significantly to pollution abatement by assimilating substances from tidal waters. Sloping barrier beaches, with their high soil porosity, help to lessen wave impact on the coast by providing a gradually increasing frictional dissipation of energy. Finally, coastal areas are extensively used for recreational boating, fishing, swimming and picnicking, as well as for passive recreation activities and for scenic enjoyment.

In general, states may legislate processes which determine permissible uses of coastal areas or which establishes the limits of local authority to use zoning ordinances in controlling the use of an area. (105) Hence, assessment of induced coastal impact requires that the analyst examine local and state ordinances which: (1) prohibit certain uses in areas to preserve intrinsic values; (2) regulate through zoning ordinances land use within specified distances from water bodies; and (3) define a regulatory process which must occur before any development can commence. The order of these conditions reflects the relative power of each in controlling development which might occur in the coastal area; that is, under the third type of regulation, it is most probable that development will be permitted, with certain conditions.

The role of the Federal government in the protection of coastal areas is clearly stated in the Estuarine Areas Act of 1968:

> ...to provide a means for considering the need to protect, conserve, and restore these estuaries in a manner that adequately and reasonably maintains a balance between the national need for such protection in the interest of conserving the natural resources and natural beauty of the Nation and the need to develop these estuaries to further the growth and development of the Nation.

The Coastal Zone Management Act of 1972 establishes a comprehensive long-range and coordinated national program. The Act declares that it is a national policy to: (109)

- preserve, protect, develop, and where possible, improve coastal resources;
- help states manage their coastal responsibilities wisely through the development of appropriate programs; and
- require Federal agencies engaged in coastal programs to work closely with state, local, regional and Federal agencies and other affected interests.

Requirements of the Act apply to the thirty coastal states, the states that border on the Great Lakes, the Commonwealth of Puerto Rico, the U.S. Virgin Islands, Guam, and American Samoa.

The Act establishes a comparatively small Federal office (centered in the Department of Commerce, National Oceanic and Atmospheric Administration) which issues designation and operational guidelines for state organizations, consistent with the following legislative direction: (110)

> The key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone.

Under the Act, the responsible jurisdiction must develop a management program for land and water resources in the coastal zone. The program must include: (111)

> (1) identification of the boundaries of the coastal zone subject to the management program;
> (2) definition of what shall constitute permissible land and water uses within the coastal zone which have a direct and significant impact on the coastal waters;
> (3) an inventory and designation of areas of particular concern within the coastal zone;
> (4) identification of the means by which the state proposes to exert control over the land and water uses referred to in paragraph (2) above, including a listing of relevant constitutional provisions, legislative enactments, regulations, and judicial decisions;
> (5) broad guidelines on priority of uses in particular areas, including specifically those uses of lower priority;
> (6) a description of the organizational structure proposed to implement the management program, including the responsibilities and interrelationships of local, areawide, state, regional, and interstate agencies in the management process;
> (7) a definition of the term "beach" and a planning process for the protection of, and access to, public beaches and other public coastal areas of environmental, recreational, historical, aesthetic, ecological, or cultural value;
> (8) a planning process for energy facilities likely to be located in, or which may significantly affect, the coastal zone, including but not limited to, a process for anticipating and managing the impacts from such facilities;

(9) a planning process for a) assessing the effects of shoreline erosion (however caused), and (b) studying and evaluating ways to control, or lessen the impact of, such erosion, and to restore areas adversely affected by such erosion.

The state or its delegate agency(ies), including regional or interstate institutions, must: (1) administer land and water use regulations, control development in order to ensure compliance with the management program, and resolve conflicts among competing uses; and (2) acquire fee simple and less than fee simple interests in lands, waters, and other property through condemnation of other means when necessary to achieve conformance with the management program. (112)

Under Section 306, grants are provided for administering the state management program. Before approving a program for funding, the Secretary must find that the program, among other things:

- has been coordinated "with local, areawide, and interstate plans applicable to areas within the coastal zone..."
- "provides for adequate consideration of the national interest involved in the siting of facilities necessary to meet requirements which are other than local in nature"
- "makes provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic values"
- will be managed by an authority empowered "to administer land and water use regulations, control development...and... resolve conflicts among competing uses"

Section 307 of the Act, which relates to interagency coordination and cooperation, states that the requirements of the Federal Water Pollution Control and Clean Air Acts, as amended, are to be incorporated in any program developed pursuant to the Coastal Zone Management Act. Moreover, the management program must adequately consider the views of Federal agencies principally affected by the program. In particular, Section 307 also states that any Federal agency which conducts or supports activities, or undertakes any development project in a coastal zone, must insure that the project is, to the maximum extent practicable, consistent with the approved state management program. (113) In particular, EPA has developed a joint agreement on the coordination of EPA Water Programs and Coastal Zone Management Programs (CZMPs) with NOAA's Office of Coastal Zone Management (OCZM) (114), a set of procedures for coordinating between EPA and the OCZM (115), and a set of guidelines for EPA participation in the development and review of CZMPs. (116)

The joint agreement between EPA and OCZM is based on the fact that both programs are concerned with management of the nation's water resources; both involve extensive planning and implementation efforts which are, of necessity, interrelated in the area of land and water uses. The agreement acknowledges that EPA regional offices must recognize that their planning, construction, and management activities should be carried out in close cooperation with CZMPs, and that they must be consistent with approved CZMPs, which are in turn consistent with the requirements of P.L. 92-500. (117)

Guidelines for EPA participation at the regional level in the development and review of CZMPs require EPA involvement early in the CZMP development process in order to insure: that EPA programs and concerns are consistent with the CZMPs; that the same data base and information are used for both programs; and that EPA have the opportunity to review CZMPs and associated environmental impact statements. The EPA-OCZM coordination agreement places particular emphasis on CZMP projections of population growth and distribution, reflecting the fact that air and water pollution requirements should be overriding, that certain uses in the coastal zone are contingent on the achievement of air and water standards, and that achievement of these standards and desired water use are contingent on supporting land uses and land use controls. (117) Therefore, the CZMP normally documents the state's and the 208 Planning Agency's projected land use planning decisions; these decisions can, in turn, serve as guidance for determining the impact of induced growth on the coastal zone. The CZMP normally describes: processes for protection of wetlands from development projects; ocean outfalls and beach uses; shellfish beds and marine sanitation devices; recreation areas; noise effects from transportation; energy facilities siting; industrial development; and dredged soil disposal. This information can assist in assessing the secondary impact of growth induced by the WWTF. In particular, the State CZMP Plan approved by EPA should be used to determine the constraints imposed on land use, for EPA is bound to conform to these requirements within the legal scope of CZMA authority. (118)

Given the above legislative and administrative actions, it is essential that the user of the manual contact state coastal zone management personnel, if the state has been delegated management authority, and understand the CZMP which applies to the area of induced growth. (119)

4.2.1 First/Second-Level Approach--Coastal Area

The first analysis step is to determine if the subarea is in a coastal management zone. If the subarea is partially or totally within a coastal zone, the CZMP will identify: boundaries of the zone, permissible land or water use in the zone; areas of particular concern within the zone; and the means by which the state exerts control over land uses, including guidelines setting priorities on use in particular areas.

If a state management program exists, EPA must be assured that the proposed WWTF is consistent with requirements of the state's approved program. Further, the state must be provided with a copy of the EPA certification; state coastal management must subsequently notify EPA that the state concurs with or objects to the applicant's certification. (120) Since state management plans typically establish procedures for public notice and public hearings on proposals for development in the coastal zone, it is likely that hearings will also be required on the WWTF.

The basic thrust of the analysis of induced growth impact on coastal zones is, thus, compliance with coastal zone management requirements where the projected growth is expected to occur in a coastal zone. The sequence of steps is: initial contact with a state agency to understand the applicable management program; and determination of the implications of the distribution of projected growth and economic activity resulting from the WWFT relative to coastal zone management requirements. If the complete analysis described in this manual is presented in draft form to the coastal zone management agency, it should serve as an adequate basis for certification. The impact of the WWTF on a coastal zone and the WWTF modifications which might be required are defined by the extent to which growth and its spatial distribution are expected to be inconsistent with existing coastal zone management objectives and procedures.

4.3 Flood Plans

A "flood plain" is an area which is periodically covered with water. The term "flood," however, extends to a wider range of meanings (as prescribed in regulations of the Secretary of Housing and Urban Development) and may include "inundation from rising waters or from the overflow of streams, rivers, or other bodies of water, or from tidal surges, abnormally high tidal water, tidal waves, tsunamis, hurricanes, or other severe storms or deluge;

inundation from mudslides which are proximately caused by accumulations of water on or under the ground; and the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels." (121)

The rarity of large floods leads many persons in high-flood risk areas to be seriously uninformed about the risks of flood damage which they face. Those who do know are often optimistic that their property will not be flooded in the near future. Other expect public assistance when the inevitable flood disaster strikes. The fact remains that flooding is a natural event (often exaggerated by the process of urbanization) and that flooding frequency can be probabilistically estimated, using historical data.

An understanding of the flood plain is important for two reasons: the process of development can affect the extent of future runoff and thereby extend the flood plain for a given frequency of flooding; in addition, increased development in an area capable of being flooded can increase the likely amount of devastation, thereby increasing the severity and cost of flooding at any given frequency. The following two sections examine the logic of flood frequency and public flood insurance programs; they provide the necessary context for consideration of induced growth impact on flood plains.

4.3.1 The Frequency of Flooding

River channel studies indicate that water flows create and maintain channels with capacity to carry flows less than the average annual flood. This means that overflow of a stream's banks will occur, on the average, about every 1.5 to 2 years. (122) The volume of the overflow varies inversely with frequency: a large number of small overflows occur frequently, with large flood or cataatrophic events being relatively rare.

If all recorded storms and their corresponding peak flow are arrayed in order of magnitude (cubic feet per second), the "recurrence interval" for different discharge volumes follows the following formula:

$R = \frac{n + 1}{m} =$ where R is the recurrence interval in years,
n is the number of years of record, and
m is the rank of the individual event in the array.

A different formula results if, instead of using peak flow for each storm, only the largest flow in each year is included in the array. Such a series ignores any lower order events in the same year, even though they may have been greater than the annual floods in other years. The use of recurrence interval data based on maximum peak flow for each year is common, and most available flood-frequency data bases reflect this. (122) (Reliability of the data on an event varies with its frequency of occurrence; data on the infrequent event are based on a single or only a few occurrences, while data on more frequent events are based on a significant amount of data. Therefore, extrapolation of a frequency-discharge curve for reliability based on infrequent events may lead to questionable results. The analyst should, therefore, use these data bases with caution.)

The "average annual flood" is the arithmetic mean of the peak flows for each year. A flood with magnitude of an average annual flood is likely to be equaled or exceeded on the average of once every 2.3 years, or 10 times in 23 years. (122)

The 100-year flood, often used to determine flood elevation for design of local land use controls, represents the flood level that, on the average, will have a one percent chance of being equalled or exceeded in any given year; it can be called the "minimum safety flood" or the "intermediate" flood, for it is a compromise between minor floods and the Corps of Engineers' "standard project flood," which is the greatest flood thought likely to occur in a given area. Therefore, the 100-year flood is often not the greatest flood of record, and the area at elevation greater than the 100-year flood plan is subject to flooding at a frequenty less than once in 100 years; given historical upstream conditions. Usually, the largest flood of record is virtually meaningless except as a measure of what has happened, for it is possible that a much larger flood can happen.

4.3.2 Flood Disaster Protection Act of 1973

The 1968 Housing and Urban Development Act established a national program of federally subsidized flood insurance. Individual property owners in participating communities may purchase insurance from private insurance agents who are reinsured by a pool of large companies subsidized by the Federal Insurance Administration (FIA). Disaster victims receive payments to cover their losses to the extent of their coverage. In order to participate in the program, communities must adopt certain prescribed flood plain management measures, consistent in design with minimum flood elevations of the 100-year flood plain. The subsidy involved in the flood insurance program is quite large; homeowners pay only about 10% of what the unsubsidized premium rate would be, although new construction is charged at full actuarial rates. (123)

The National Flood Insurance Act, originally enacted in 1968, prohibited flood insurance for a community until detailed hazard maps were completed and actuarial rates established. The Housing and Urban Development Act of 1969 established an emergency program during which subsidized insurance could be purchased prior to completion of a Flood Insurance Rate Map for the community. (Upon completion of the rate map, the community becomes eligible for and must comply with the regulations of the regular program.) (123)

The Flood Disaster Protection Act of 1973 (P.L. 93-234) expands flood insurance program coverage, and makes coverage compulsory for communities designated as flood prone. This program has two objectives: (1) to provide a smoother working mechanism for disaster relief; and (2) to eventually reduce flood losses by encouraging flood plain management. Both Acts provide for low cost flood insurance for projects in flood-prone areas through the means of a subsidy and require, as a condition precedent, the enactment of local jurisdictions of land use and control measures to guide the use of flood plains. (124) (125) Under the Flood Disaster Protection Act, the insurance subsidy ends for other than existing buildings after detailed insurance rates maps have been prepared. With the high subsidy, the flood insurance program may not directly save the Federal Government any money over grant and loan programs but, because of unsubsidized rates for new construction and the land use control requirements, the intent is that eventual flood losses will be greatly reduced by discouraging new construction in flood plains.

Two enforcement strategies are available. One strategy forces communities to participate in the program: by July 1, 1975, or one year after notification that they are flood prone, whichever is later, all flood prone communities must join the program. After July 1, 1975, no financial assistance from Federal agencies for acquisition or construction or for real estate loans by federally supervised lending institutions for buildings will be available to nonparticipatory communities within the identified flood hazard area. Moreover, EPA is prohibited by law from making any grant for acquisition or construction purposes in a flood hazard area in these nonparticipating communities. (124)

The list of communities to which this prohibition applies on July 1, 1975 has been published by HUD and is regularly updated by notice in the Federal Register.

The second type of enforcement strategy requires individual flood plain property owners in communities which have joined the program to purchase insurance. Federal agencies will not provide assistance for acquisition or construction, nor will federally supervised instructions make loans for real estate to individuals within identified flood hazard areas unless flood insurance is purchased. Coverage is required up to the amount of the assistance or loan or the maximum available under the program, whichever is less.

The Flood Disaster Protection Act of 1973 also extended the emergency program for two years, and delayed the charging of actuarial rates for new construction until December 31, 1974, or until publication of a flood insurance rate map for a community. The distinction between this emergency program and the regular program is very important to the program's objective of discouraging unwise development of flood plains.

The FIA uses "Flood Hazard Boundary Maps" to identify in a community the areas of special flood hazard; these maps simply delineate the 100-year flood plain and are the basis for the enforcement strategies. More detailed flood insurance rate maps are required for a community to join the regular program and to charge actuarial rates for new construction. Any flood plain construction initiated prior to publication of the rate map may be purchased at subsidized rates. In addition, the land use controls required of local communities are relatively lenient until the rate map is published. To join the regular program, a community must require that all new flood plain construction be elevated above or flood proofed to the 100-year flood level. Only a small portion of these have published rate maps and are included in the regular program. Therefore, completion of flood insurance rate maps is critical to the effect of the insurance program on flood plain development. (123)

Flood Hazard Boundary Maps, which are maintained on file within each participating community in a repository designated by the mayor or chief executive officer, can be used to identify the special flood hazard areas in a community. The address of such repository is published in the Code of Federal Regulations (127) and is amended regularly in the Federal Register. The Flood Insurance Rate Maps, where available, delineate degrees of flood hazard and include precise area identification. (126)

Additional maps, literature, and policy application forms and manuals are available from any National Federal Administration insurance servicing company, which is also equipped to answer questions on eligibility of communities. Questions which can not be answered by individual agents or brokers or by the appropriate servicing company may be referred to the National Flood Insurance Association, 1755 Jefferson Davis Highway, Alexandria, VA, 22202 (telephone: 703-920-2070); to the flood insurance representative at the nearest HUD regional office; or to the National Flood Insurance Program, HUD, Washington, D.C. 20410 (toll-free telephone 800-424-8872). (126)

4.3.3 First/Second-Level Approach

The analyst should first determine whether any portion of the subarea has been identified as a special flood hazard area, as shown in a "Flood Hazard Boundary Map." (Sources of information include the appropriate Flood Insurance Specialist in the nearest HUD regional office and the State Coordinating Agency--the state agency designated by the Governor to coordinate the activities of the flood insurance program and to assist communities in that state.)

Second, the analyst should determine which, if any, portions of the subarea have submitted an application to FIA. (HUD, or a designated state agency, can provide this information.)

Third, the analyst should determine if the community has qualified for the flood insurance program. Officials in the community are advised by letter of the date that the sale of flood insurance will begin; press releases announcing the community's eligibility are sent to the community for use by local newspapers and radio and television stations; notice is also published in the Federal Register.

Given the above information, the analyst should:

- locate property within the subarea which is subject to flooding, as defined under the Act; and
- determine what land use control measures apply to the flood prone areas.

From a review of land use and control measures included in the applications for the flood insurance program, the analyst should be able to determine the extent to which development is discouraged in the flood plain as required by the regulation. (128)

By mapping (preferably by overlay) the flood hazard area and by comparing the location of this area with induced growth locations, identified in Chapter 2, the analyst can judge the probable level of development in the flood hazard area. If significant development is likely to occur in the flood hazard area, and there is no flood insurance program for the community, one can infer that this development can lead to increased potential for economic and physical losses from flooding, and that there is, therefore, secondary impact of the proposed WWTF. If there is induced development in the flood insurance area, the community has applied to be in the flood insurance program, and the rate map has not yet been published, it is likely that there will initially be rapid development under comparatively lenient local controls, because developers can purchase flood insurance at subsidized rates, while not meeting the more stringent standards of the regular program.

If induced development in the flood hazard area is anticipated even after it is recognized as a flood hazard area, and the community has been found qualified for the flood insurance program, it is likely that: (1) some of this projected development will locate elsewhere, due to sanctions inherent in the program; and (2) the development that does occur will meet the program's requirement for flood proofing. For development which will relocate out of the flood hazard area, the analyst should consider the next most likely location and correct any impact observations for these other areas.

4.4 Wildlife Habitats

Wildlife and its habitats are defined as "birds, fish, mammals, and all other classes of wild animal and all types of aquatic and land vegetation upon which wildlife is dependent." (129) Fish or wildlife are further legally defined as "any wild mammal, fish, wild bird, amphibian, reptile, mollusk, or crustacean, or any part, products, egg, or offspring, or the dead body or parts thereof." (130)

Use of land in a subarea for agricultural purposes or for parking lots and high-rise buildings can decrease the extent and types of wildlife habitat available in the impacted subarea. Wildlife habitat encroachment can also result from more intense human activity in areas near existing wildlife habitats. For example, human disturbances can seriously interfere with the successful pairing, feeding, and nesting of some birds (including the California condor and the bald eagle), perhaps leading to extinction of these birds in their natural wildlife habitat. Further, the life cycle of these species can be impacted through introduction of pesticides in urban areas; these pesticides build up to higher concentrations through the biological chain and may affect reproduction. Conflict between wildlife use and human activity is also found where certain species become accepted as targets for game hunting or for destruction when they infringe on the economic produce of man's activities. The coyote, the bighorn sheep, and the wolf are examples of wildlife whose ranges have been infringed upon and whose survival has necessitated concerted preservation effort by persons concerned with the maintenance of the full spectrum of wildlife species and subspecies. (131)

However, certain species of wildlife have flourished in urban and semi-urban areas, under proper conditions. For example, deer populations have increased where cutting of woodlands has permitted new growth for deer forage; and wild ducks often winter in urban ponds. (132)

Among the various pieces of legislation protecting fish and wildlife is the Endangered Species Act of 1973. The goal of the Act is to preserve, restore, and enhance in their natural ecosystems all species of animals and plants that are endangered with extinction or are so threatened. In addition to requirements for identifying and listing species of animals which are endangered and to providing authority for establishing enforcement actions, the Act provides for a state grant-in-aid program to carry out endangered and threatened species protection and management programs.

In order to assess the impact of a proposed W TF on wildlife habitats, it is necessary to determine how the project affects the diversity and stability of wildlife in the area impacted by the project. It is generally felt by ecologists that species diversity and stability reflect the state of health in the wildlife habitat. Actions by man which decrease the diversity or stability are viewed unfavorably. When a particularly unique or rare species is endangered by the proposed project, then its survival must be viewed in a context larger than the immediate area's stability and diversity (e.g., the species could have national significance).

Rigorous analysis of induced growth impacts on wildlife habitats requires trained field ecologists who know local native species and how these species fill their respective niches, spatially and temporally. Therefore, less extensive approaches are usually suggested, unless it becomes clear that unique or rare species may, indeed, be endangered. The most common approach is assessment, using existing listings (or mappings), of species which are most likely to inhabit an area of concern. This is the approach developed in the following section.

4.4.1 First/Second-Level Approach--Wildlife Habitat

The analysis which follows is designed to identify wildlife species and their habitats in the subarea in order to determine (1) existence of any endangered species; and (2) the extent of possible impacts on all species (including those endangered) due to induced growth.

Local conservation commissions, city or town departments of natural resources, local public works departments, local zoological societies, and Audubon Societies can assist in identifying species present in the area, their habitats, and any wildlife refuges in and related to the subarea. If information from these sources is not available or is incomplete, a field survey of potentially affected areas may be required (using qualifed agency staff or consultants) to inventory species present and the resources necessary to maintain their existing habitats. This inventory should identify the following habitat characteristics:

- reproductive areas
- escape cover
- feeding areas and sources of food and water
- presence of wildlife refuges or preserves

This inventory should be checked against the List of Threatened or Endangered Species, obtainable from the U.S. Department of the Interior (131), state conservation agency, or the Bureau of Sport Fisheries and Wildlife (Fish and Wildlife Service, U.S. Department of Interior). The listing gives the species name, distinguishing characteristics, present distribution, size of population, estimated numbers, breeding rate in the wild, reasons for decline, protective measures already taken, measures proposed, number in captivity, and bibliograpic references.

A mapping of this information (by overlay) will permit the user to relate the parcels of land which may be developed, with and without the WWTF, to the location patterns of species which might be impacted by development.

If a threatened or endangered species will be affected by induced development and/or population growth, the Department of the Interior, Office of Endangered Species and Fish and Wildlife Service Regional Offices, should be consulted. The Department is charged by the Endangered Species Conservation Act of 1969 with the "conservation, protection, restoration, and propagation of selected species of native fish and wildlife, including migratory birds, that are threatened with extinction." In some cases, the Department may acquire lands or waters (or interests in lands or waters) under the Land and Water Conservation Fund Act of 1965. (134) Moreover, under Section 7 of the Endangered Species Act of 1973, other Federal departments and agencies are to coordinate and consult with the Department of the Interior to ensure that in carrying out their programs, they "...do not jeopardize the continued existence of...endangered species...or (destroy or modify)...habitat of such species which is determined by the Secretary (of the Department of Interior) to be critical."

If negative impact on any species is judged to be potentially significant, more detailed studies of inventoried species and habitats may be necessary. Information should be gathered on food, nesting, cover requirements, and their relationships to each other and the surrounding environment; plant materials meeting this requirement; size requirements of habitats; degree of wildlife tolerance to air, noise, water pollution, and changes in water or air temperature and humidity, and to human proximity. This information may have to be obtained from outside professionals in zoology, biology, or botany, if in-house expertise is unavailable. The Bureau of Sport Fisheries and Wildlife (Division of Wildlife Services, U.S. Department of the Interior) can do surveys of wildlife population and characteristics, and has done studies which might be pertinent to the species and area under scrutiny. Field guides and local checklists from local zoological or conservation societies will be useful if data must be collected first-hand.

The types of species and impacts which are likely to occur and should be included in this analysis include the following: amphibians and reptiles which depend on a habitat very sensitive to environmental changes; frogs which spawn in pools and need moist, shady woods with much cover; landfill projects which endanger breeding pools. Bulldozing and dredging are also a threat, particularly during hibernation, because they remove ground cover and underbrush. Lowered water tables reduce spawning sites, and egg-eating among remaining species may result. Draining and filling removes marshes; culverts can enclose creeks. Channelization accelerates runoff and can thus remove temporary breeding pools. The flow of streams may decrease, reducing food and aquatic habitats. Housing construction and paved roads adversely affect stream area habitats by removing bank cover, increasing runoff, siltation, and bank erosion, making some species more vulnerable to predators, and removing burrowing and nesting areas. Urban development can lead to decreases in dissolved oxygen levels and humidity and to increases in air and water temperature. Roads can present barriers to seasonal movements of some species, separate them from food sources, and thus heighten the likelihood of their being injured or killed while trying to cross. Industrial pollution and septic tank effluents can kill or decrease aquatic animal or plant life. Pesticides and herbicides can cause direct destruction of wildlife and habitats, or can cause detrimental changes in the organisms and increase susceptibility to disease. Urbanization can endanger common wildlife such as robins. More intensive human activity on the ground makes nesting in lower branches difficult. However, tree squirrels may find new food sources and be able to adapt well to developed areas, but may thereby become nuisances to human residences. (132)

Different types of development may have different *degrees of impact*. For example, family-type residential development with higher bedroom counts tends to have more impact on wildlife areas: single-family residential or garden-type apartment construction characteristic of housing for younger, larger households require more land area and are associated with children, dogs and cats, which can cause considerable habitat damage. Housing for the elderly, with smaller, more compact units and developments, might have less impact. Outdoor recreation facilities for active sports are more likely to adversely affect wildlife habitats than facilities for "passive" recreation, such as nature study, hiking trails, and so on. It may be possible to locate low-impact development or to avoid development near habitats most sensitive to disturbance.

Wildlife interest groups in the impact area should be contacted during the study. Not only may they be able to supply valuable habitat information, but involving them in the impact study process may produce a better understanding and acceptance of the proposed project.

A final step, particularly if threatened or endangered species are affected, would be the identification of nearby areas which could offer habitats to replace those disturbed or altered or to which the species could be expected to move. Such areas could be marked for special preservation or protection; or use could be restricted, depending on present ownership, use, and future development potential. Such a study would, again, require the use of wildlife management specialists and close coordination with state and local bodies having jurisdiction over wildlife.

5.0 UNIQUE AREAS

Induced development due to the proposed wastewater treatment facility can affect parklands, wild and scenic rivers, and properties with historic, architectural, archaeological, or cultural value.

The difficult task of defining values and potential secondary impacts on these values requires: (1) definition of the importance of these resources to man's present and future needs; (2) assessment of present and projected uses of these resources, and the implications of these patterns of use for inherent resource values; and (3) identification of the protective devices which might insulate existing values from these secondary effects. This information is essential to answer the question: "Given projected levels and patterns of induced growth, are potential impacts on parkland, wild and scenic river, and historic, architectural, archaeological, or cultural values inconsistent with preservation objectives for these resources?"

The variations of unique area impact analysis described in the following sections are all limited, mainly because the extent to which these values are "preserved" is often a judgment which depends on the perspective of the observer. For instance, parkland may be preserved in its natural state, thus supporting a variety of plants and animals, but limiting its capacity for human use. On the other hand, open spaces may be developed as parklands designed to support relatively intensive human use, thus compromising its diverse natural variety. Does one of these uses preserve parkland values and the other destroy them? The answer is largely judgmental, and depends on one's definition of parkland and appropriate parkland use. Further, in regard to historic preservation, is proximate growth consistent with preservation of the intrinsic historic value of an area or structure? Does an historic site retain the original bucolic atmosphere which may have been part of its historic value when it is constantly crowded with sightseers? Finally, at what point does an additional canoe on a wild or scenic river destroy the feeling of wilderness or scenic value to the users? Similarly, it is difficult to judge at what point the development of parkland for recreation compromises its value for preservation. Conclusions regarding the point of compromise will depend on professional judgment.

5.1 Parkland

Changes in population and economic growth may place pressures on land, limiting the amount available for parkland use. Growth may lead to fundamental conflicts regarding intensity of open space and parkland use and may contribute to deterioration in values, increased costs of maintenance and management, requirements for new regulation or user fee devices to effectively control demand, and increased costs of acquiring land for parkland purposes in order to satisfy the entire range of demands for parkland values.

This section examines the WWTF and induced growth impact on parkland in the subarea in order to determine if the types of effects described above will be significant.

5.1.1 First-Level Approach--Parklands

The first-level approach consists of definition of existing and proposed local and nonlocal parkland, examination of growth implications for existing and proposed parkland, and an assessment of the protective devices which might lessen expected parkland impact. The approach is structured around three analysis questions.

The first two parallel questions deal with local and nonlocal parkland impact. The distinction between local and nonlocal parks hinges on administrative control. Local parkland is defined as that land which is controlled by individual municipalities in the subarea. Nonlocal parklands are defined as land over which the community has no direct control; control can be exercised by a county, region, state, or Federal institution. Usually these parklands serve as an alternative to local parklands and often play a role in recreational interests which complement opportunities provided by local parks.

1. Will the intensity and type of use of local parkland be increased? And, if so, can it be adequately handled?

Three types of data are required as inputs to address this question.

First, the analyst should refer to the results of analyses in Chapter 2 (Sections 2.2 through 2.3). These analyses provide maps of portions of the subarea which will be impacted by growth with and without the proposed WWTF. A comparison of these two maps should identify those areas where growth will be less due to the proposed facility and greater due to construction of the WWTF.

Second, for subareas where growth is projected, present parkland use should be defined. Street and land use maps should identify parks and their characteristics, including:

- size and use capacity,
- types of use,
- population served (users),
- ownership/control,
- maintenance (responsibility and annual costs),
- sensitive resources (wildlife, vegetation, and water), and
- the nature of past external infringement of other uses into the parkland.

Third, parks under development should be identified. Local personnel involved in the operation of public parks and property, including local planning boards, should provide the following information on parkland being considered:

- present ownership (including restrictions in deed or by community),
- size,
- anticipated users (age, residence, how arrive at parkland),
- use (seasonal, diurnal),
- planned capacity,
- sensitive resources (wildlife, vegetation, water),
- expected maintenance (by whom, costs, problems),
- equipment and facilities (capital investment) required, and
- possibilities for expansion.

Based on these three types of information, and with the assistance of information and services of local recreation planning studies and personnel, the analyst should:

- determine which future local parklands, fiscal resources, and maintenance expenditures are to be allocated to those parts of the community which will undergo growth and, in particular, growth induced by the proposed WWTF;
- determine whether future intensity of local parkland use, by type, will be significantly greater than present use;
- determine whether population growth and distribution with the proposed facility, will cause deterioration of local parkland, given the availability of existing and anticipated parkland.

2. **Will the intensity and type of use on nonlocal parklands in the future be significantly increased?**

Nonlocal parklands may be defined as those over which the community has no direct control; they may be county, regional, state or Federal parklands. Usually, these parklands serve as an alternative to local parklands and often play a role in recreational interests which complements the uses provided by local parks.

Recreational officers responsible for nonlocal parklands should be contacted in order to obtain the same information (as noted above) for local parklands and to conduct the same type of analysis.

Federal and state parks are most likely to have complete information available. The National Park Service has the largest jurisdiction over federal parklands, but the Bureau of Outdoor Recreation (U.S. Department of the Interior) has funds for recreational assistance and does extensive planning in this area. (135) In addition, the following Bureaus of the Department of the Interior have jurisdiction over various federally owned parklands:

> Bureau of Sport Fisheries and Wildlife is responsible for conservation of wildlife and natural habitats, with most of its land found in rural areas;
>
> Bureau of Land Management has jurisdiction over lands for their consumptive products--minerals, timber, grazing, etc.--but has authorization to manage the land as a recreational resource also.

State Park and/or Recreation Departments should be contacted for information on the extent to which state-owned parklands might be impacted. Usually such state departments have information on number of visitors, projection of use, capacities, plans for expansion, etc.

Another possible source of information on parklands in general is the National Recreation and Park Association.

It will be difficult to distinguish the impact on nonlocal parkland due to induced growth, particularly as the distance to the nonlocal parkland increases. Therefore, if the user of the manual can demonstrate that future growth within the subarea will not be significant enough to increase the intensity, type of use, and capacity of nonlocal parklands serving the area, then one can assuredly conclude that there will be no impact on less proximate parkland. If this is not the case, then the user will have to make a judgment regarding significance, based on the information as suggested.

3. Are legislation and/or interest groups in existence which might assist in maintaining the existing purposes of the parklands?

All existing and future local and nonlocal parkland should be characterized in terms of ownership and the restrictions which have been placed on it. For example, some public parkland may have been one given to a local community in trust, thus assuring its use for a specific purpose. Very often, parkland bought with assistance of Federal or State funds must be used for purposes for which the funds were expended. Therefore, it is important to ascertain how the parkland was acquired; this information is often available from local and state officials.

Local or regional users of park facilities (ranging from Scout groups to local environmental organizations) should also be contacted in order to obtain information from them on the strength of public support for these parkland values.

The answer to these three questions should be based on a thorough examination of available information and on interviews with informed individuals. If analysis indicates that the carrying capacity of local parklands will be exceeded, that the intensity and type of use on nonlocal parklands will be significantly increased, or that there will not be sufficient protection to maintain the quality of existing parklands, then the user has to clearly ascertain whether this impact is from induced growth or from normal population growth, which could be expected in the absence of the WWTF. The second-level approach assists in this regard.

5.1.2 Second-Level Approach--Parklands

The second-level approach should be used for facilities in areas where there is potential for significant impact, or where existing data is inadequate to make a conclusive evaluation of the impact using the first-level approach. In order to assess impact on parklands, it is necessary to determine parkland "carrying capacity" and assess the impact of increased usage relative to this capacity. This second-level approach follows the same analysis logic as the first-level approach, but produces analytical results with which estimates of potential imbalance between projected use and available parkland can be made much more rigorously.

At this level, the analyst should develop additional information on the types of users and demand on parkland under the induced-growth scenario. Generally, demand for recreational activities can be determined using socioeconomic characteristics and prices willingly paid by the user. (135) Specifically, current income distribution, car ownership, transportation use, and other demographic data on parkland users in the area and potentially impacted subareas can, in conjunction with land use and growth estimates with the WWTF, indicate the types of demands which are likely to be placed on existing and proposed parkland. (136) (137)

Determination of Carrying Capacity

The refined parkland demand data should be matched with refined parkland supply information. Specifically, a more precise estimate of parkland availability is developed through exploration of parkland "carrying capacity."

Carrying capacity is defined as the maximum amount of use that parkland can sustain without experiencing a decline in user satisfaction of environmental quality.

A variety of carrying capacity indicators have been developed, including "standards" for parkland area per user, facility arrangements, and levels of service. The user of the manual should review applicable standards, such as those set by the state for its Outdoor Recreation Plan, those published by the Bureau of Outdoor Recreation, as well as those suggested by the National Recreation and Parks Association. (138) Some individual parks have adopted standards, particularly larger ones serving regional needs (these standards may be obtained from the park management). If a park is under Federal jurisdiction, standards for its use must be established by the managing agency, under the provisions of the Land and Water Conservation Fund Act of 1965. (139) Many states have developed standards for use of state-owned parks and also for parks under local management. Community leaders and recreation officials can also be consulted for information on how much parkland of various types is needed to accommodate a given population without exceeding established capacity limits.

Environmental standards provide another measure of parkland carrying capacity which might vary considerably depending on the location, type, and use of the parkland. Once standards appropriate to the parkland under study have been defined, they must be applied to the parkland to learn whether the park is presently being used at capacity, whether it is used at capacity only in certain parts or at certain times of the day or year, and what capacity, if any, exists for additional use. Current use data may have to be collected. This might involve a user questionnaire to determine numbers and characteristics of users, how the parkland is used, and attitudes towards the parkland and other users. Residents of the neighborhood or wider area served by the park might also be surveyed.

Comparison of Projected Parkland Demand and Availability

When use standards and estimated capacities of existing parklands have been defined, projected population increases and patterns of parkland use (with and without the project) can be used to determine whether existing parklands will be adequate to accommodate future demand resulting from the construction of a wastewater treatment facility or whether additional lands will be needed. For example, if, in a given area, it is learned that a standard of 8 acres of parkland is needed for each 1000 residents in a typical urbanized area, and inventories reveal that 32 acres of parkland now serve an area with 2000 residents, it is clear that this area can accommodate an increase in population of some 2000 residents without experiencing a degradation of its parklands through overuse.

However, individual parklands may already experience overuse at certain times of the day or year or for certain activities. Capacities for individual parks should, thus, be compared to projected in increases in particular user populations with an interest in the individual parks within the subarea of projected growth.

The parklands or parts of the parklands which will be impacted by population growth induced by the proposed project should be clearly identified on a map of parklands.

The estimated induced parkland impact will depend to a large extent on the user's interpretation of the previously described information and data. A difficulty which can perhaps be expected is distinguishing between a parkland severely impacted by growth without the WWTF, and the marginal or additional impact which will result from the induced population growth. In a case such as this, preservation measures to protect against any future impact would probably be sufficient to protect the parkland against the induced growth;

however, the user of the manual will have to judge whether such measures are likely to be enacted with sufficient legal sanctions.

5.2 Wild and Scenic Rivers

Wild and scenic rivers are protected under the Wild and Scenic Rivers Act, passed initially in 1968 for the purpose of preserving in a free-flowing condition those rivers or segments of rivers possessing "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values." (140) Components of the wild and scenic rivers system may be authorized by Congress or designated by state legislatures. Criteria for inclusion in this system are found in Bureau of Outdoor Recreation's Guidelines: (141)

(1) Wild River Areas -- Those rivers or sections of rivers that are free of inpoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. (142)

(2) Scenic River Areas -- Those rivers or sections of rivers that are free of impoundments with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. (143)

(3) Recreational Rivers Areas -- Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past. (144)

Administration of designated areas may be the responsibility of one of several Federal agencies or state or local governments. Land or interests in land within the boundaries of any component of the national wild and scenic rivers system may be acquired by the Departments of the Interior and Agriculture in order to assure its protection.

Land immediately adjacent to such rivers is also protected; only activities which do not interfere with characteristics which qualified the area for inclusion in the system are permitted.

Secondary effects of wastewater treatment facilities on a wild or scenic river must be assessed, even though a plant may not discharge into a river or be located near enough to it to be included under Section 1278 of the Act, which states that: (145)

> ...no department or agency of the United States shall assist by loan, grant, license, or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which such river was established, as determined by the Secretary charged with its administration. Nothing contained in the foregoing sentence, however, shall preclude licensing of, or assistance to, developments below or above a wild, scenic or recreational river area or on any stream tributary thereto which will not invade the area or unreasonably diminishes the scenic, recreational, and fish and wildlife values.

The secondary impacts of WWTF may be considered under the National Environmental Policy Act, which requires that an environmental impact analysis must document the environmental impact resulting from growth in the subarea; in this case, impact can be measured by ascertaining effects on the values for which such rivers were established. The Wild and Scenic Rivers Act has generally been considered by EPA to be one of the environmental laws against which the potential secondary environmental effects of a construction grants project can be measured in accordance with the policy set forth in PGM #50. (3)

5.2.1 First-Level Approach--Wild and Scenic Rivers

1. Does the subarea include any wild, scenic, or recreational river areas included, or proposed for inclusion, in the National Wild and Scenic Rivers System?

A listing of the rivers or portions of rivers included in the system may be obtained from: the nearest office of the U.S. Department of the Interior; the Department of Agriculture; state departments of agriculture, public works, or natural resources, etc., and local conservation groups. Notification of designation is also published in the Federal Register.

If there are rivers, or portions thereof, within the subarea which are part of the proposed system, the analyst should determine under which category--wild, scenic, or recreational--the area was designated and what particular values were used in making the designation. This information can be obtained from the sources listed above.

If there are rivers within the area which are not designated, but appear to have wild-scenic attributes, the analyst should refer to the U.S. Guidelines to determine if these rivers are likely prospects for designation. The user should refer to the Guidelines with the understanding that the standards for inclusion of rivers in the wild and scenic system are not absolute nor always binding; the criteria for designation are normally applied with considerable judgment. The Guidelines also prescribe management practices to preserve the character of the designated area; again, considerable judgment is often used. The Guidelines do not prescribe the acceptable attributes of projects outside the immediate area as they affect wild, scenic, or recreational rivers; prohibitions relate only to structures or activities within the designated river area.

2. Are any national forests, wilderness areas, or wildlife refuges part of the wild and scenic river area?

If such areas are found to exist, the National Park Service, Department of Interior, National Forest Service, Department of Agriculture, Fish and Wildlife Service, Department of Interior, or state or local agencies having jurisdiction should be contacted for information regarding sensitive environmental characteristics of the area, protective legislation, etc. (See also Sections 4.4, 5.1).

3. Will the projected growth and distribution of population resulting from the WWTF be in the area designated under the Act?

The analyst should map the boundaries, both land and water, of the areas designated under the Wild and Scenic Rivers Act. By matching this map against the map of projected population growth and distribution (2.3.3), the analyst can determine if the area will be impacted under the proposed WWTF. If there will be impact, and if growth is significantly greater than would have occurred without the WWTFs, then one should determine how it might alter the character and value of the river. This analysis should consist of a specific and detailed statement of development which is expected to occur.

The user of this manual should also determine if the proposed sewer alignment induces growth away from the area designated under the Act. If so, this positive (reduced growth) impact should also be noted.

4. Will growth be compatible with the purposes of the designation, under the Wild and Scenic Rivers Act?

If projected development reduces pressure on the designated river or is judged to be compatible with the designated use of the river, this situation should be documented, and the analyst should turn to next type of impact. If, however, a river area can be expected to abut areas of growth and change, or be subject to pressures which are incompatible with the purpose for which it was designated (and this is due to the proposed WWTF), additional analysis should be undertaken, using the second-level approach.

5.2.2 Second-Level Approach--Wild and Scenic Rivers

The second-level approach should be used only after first-level analysis is complete. To analyze the significance of the impact of population growth and distribution on wild, scenic or recreational rivers, an analysis of the characteristics of the river first should be undertaken. All reports, maps, descriptions or other documentation prepared or submitted to the Secretary of the Interior in connection with an application for including the river in the National Wild and Scenic Rivers System should be obtained.

Copies may be available at the state level. The administering agency should also be contacted for information pertaining to the river area. It may also be necessary to perform a field inventory to identify features of the river which qualified it for inclusion in the system. This survey could be done in conjunction with surveys or inventories of parklands, wildlife habitats, wetlands, flood plains, for other sections of the study. Distinguishing features should be mapped. River characteristics to consider in this inventory should include, but are not restricted to: access, existing development, recreation resources (trails, swimming, fishing, hunting, etc.), permitted and prohibited or regulated activities, presence of wildlife, types of vegetation, vistas or other scenic features, and easements or rights-of-way granted.

The analyst should next determine potential secondary impacts. Ways in which anticipated growth and development might adversely affect the wild and scenic river area include: development near the area that is visible from the area and, thus, damages its wild and scenic qualities; runoff from new access roads nearby adversely affecting soil and water quality; more heavily travelled access roads which lead to noise and air pollution, damaging the quality of the wild and scenic environment; more dense human population which causes migration of some types of wildlife away from the area (see also Chapter 4 for other impacts on wetlands, flood plains, and wildlife habitats); increased population and economic activity which leads to heavier recreational use of the area, raising possibilities of deteriorating water quality, stock of wildlife, and quality of recreational experience (see also Section 5.1 Parklands). In some cases, evaluation of environmental effects (such as noise pollution and water quality) should be undertaken by planners with expertise in those areas if they appear to be potentially damaging to the wild and scenic river area, thus leading to a violation of the standards enumerated in the Wild and Scenic Rivers Act and expanded upon in the Guidelines.

5.3 Areas of Historic, Architectural, Archaeological, or Cultural Value

The National Historic Preservation Act of 1966 (PL 89-665) establishes a national policy for historic preservation, stating "that the historical and cultural foundations of the nation should be preserved as a living part of our community life and developed in order to give a sense of orientation to the American People." The Act directs that the National Register of Historic Places be expanded to include properties of state and local as well as national significance, establishes the Advisory Council on Historic Preservation, and requires that the Council be allowed a reasonable opportunity to comment on any undertaking which involves the Federal government and might affect a National Register property. Executive Order #11593 enlarges the role of the Council in Federal decision-making by requiring that it be provided an opportunity to comment on undertakings affecting properties eligible for nomination to the National Register as well as to those already listed in the National Register.

Justification for preservation of areas of historic, architectural, archaeological or cultural values incorporates arguments based on historical, social, psychological, educational and economic factors. Among these factors, six rationale for preservation of manmade artifacts and districts are commonly advanced: (144)

> First, it is argued that an environment with cultural and historical continuity is socially beneficial. A community ought to preserve some parts of its past in order to recognize what it is, how it became what it is, and how it differs from others.
>
> Second, daily life is enriched through preservation of historic sites and buildings. This assumes that temporal variety and architectural diversity in the environment are more desirable than homogeneity and monotony and that preservation of historic architecture enriches the environment.

> Third, preserving the visual reminders of a community's past allows people to relate to events, ideas, movements, and persons believed to be important to understand and honor. Also, the presence of the physical past helps to fulfill society's expectations and anticipations for the environment and promotes well-being.
>
> Fourth, it is argued that notable architecture and landscapes should be preserved on the basis of their intrinsic value as art.
>
> Fifth, in some cases, preservation of historic areas stabilizes or increases the economic base of their locales. This is the prevailing justification for the approval of historic district ordinances by State Supreme Courts.
>
> Lastly, socially oriented preservation programs can be important for maintaining socioeconomic characteristics of neighborhoods. In the few cases where preservation programs are so directed, they may complement traditional urban renewal programs, with the advantage that displacement of residents is not necessarily required.

Under the National Environmental Policy Act (NEPA), one stated environmental policy goal is to "preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice." (147) In order to meet this objective and those set forth under other relevant Acts and authorities (148), the Advisory Council on Historic Preservation has defined "Procedures for Protection of Historic and Cultural Properties," commonly referred to as "Part 800." (149) In order to meet the objective of NEPA and its other objectives, the Advisory Council has instructed Federal agencies to coordinate NEPA compliance with its other responsibilities, thereby assuring that proper consideration is given historic and cultural resources in the preparation of environmental impact statements. Where both NEPA and the National Historic Preservation Act or Executive Order #11593 are applicable, the Council on Environmental Quality has directed that compliance with Section 102 (2)(C) of NEPA should, to the extent possible, be combined with other statutory obligations to yield a single document which meets all applicable requirements. (150) The obligations of a Federal agency pursuant to the National Historic Preservation Act and Executive Order #11593 are independent from NEPA and must be complied with even when an environmental impact statement is not required. (149)

The U.S. Environmental Protection Agency's policy is that the procedural requirements of the Advisory Council regulations apply solely to the primary effects of a Federal project. (151) EPA's responsibility to analyze secondary effects of properties arises under NEPA and is therefore governed by NEPA procedures. (152)

In particular, any action which may have an effect on a National Register property or an historic place which appears eligible for listing in the National Register must go through two integral but separate review procedures. First, an environmental impact assessment identifies those resources potentially affected by the proposed project. Second, where identification of these resources indicates that properties included in the National Register may be affected, evidence of compliance with the review requirements of 36 CFR Part 800 must be included in the environmental impact assessment and/or EIS Comments by the Advisory Council on Historic Preservation. These requirements are more fully described (in sequential steps) in the following pages.

In addition to the review process established by the National Preservation Act of 1966, up to fourteen departments of Federal agencies administer important programs affecting preservation (153) and which must, therefore, be considered in the analysis of WWTF secondary impact. The most significant programs are described below.

The Department of Housing and Urban Development (under the Housing Act of 1949) has operated several programs significant to preservation efforts (chiefly the Open Space, Urban Beautification, and Section 709 Historic Preservation Grant programs). Most of these programs were suspended by executive order in January 1973, although some may not as yet have been closed out.

The Department of Transportation under Section 2(b)(2) and 4(f) of the 1966 Transportation Act is required to make special efforts to preserve historic sites and structures. No approval of any transportation project affecting historic property of Federal, state, or local interest may be made if possible alternative exist.

The Land and Water Conservation Fund (Public Law 88-578, 1964) provides matching funds for outdoor recreation purposes, including archaeological and historic sites.

Federal Executive Order #11593, February 1972, requires all Federal agencies to survey all their lands and buildings and nominate appropriate ones to the National Register. The agency is then required to make positive action plans to protect all lands and buildings so listed.

While not aimed specifically at local preservation programs, general revenue sharing funds may be used for these purposes and have been so used in several cases.

All fifty states now have federally approved statewide historic preservation plans. In 1972, the Advisory Council on Historic Preservation identified and analyzed state laws and prepared guidelines for state legislation in an attempt to achieve generally more comprehensive and consistent programs. (154) These guidelines propose creation of state agencies which, to some extent, replicate existing agencies at the federal level.

With this background in mind, the analyst should proceed with secondary impact analysis through application of the following sequence of tasks:

(a) locate, inventory, evaluate and describe all properties which fall within the guidelines and which may be impacted by the WWTF;

(b) assess the extent and type of impact which may occur on these properties, and any mitigating steps which are available to reduce adverse impacts;

(c) coordinate, when applicable, plans, program, procedures and activities with the Advisory Council on Historic Preservation, the Secretary of Interior, State Historic Preservation Officers (SHPO), The National Trust for Historic Preservation, the Smithsonian Institution, and other Federal, State, or local historic organizations.

5.3.1 First-Level Approach

Step 1. Identify Properties of Historic, Architectural, Archaeological or Cultural Value Subject to Secondary Impacts.

If a proposed wastewater treatment facility funded in part or whose by Federal funds is likely to have secondary impacts on properties which are listed in the National Register of Historic Places (published in the Federal Register each February with supplements on the first Tuesday of each month) or eligible to be listed there, these properties should be identified and applicable statutes and regulations adhered to.

Identification of properties begins with consulting the State Historical Preservation Officer (SHPO), the National Register, and its supplements. The Register lists, by state, places of national, state, or local architectural, archaeological and cultural, as well as strictly "historic" significance. The significant character of property which qualifies for inclusion in the National Register is contained in the brief description of each property in the Register. (The Register may be available at larger public libraries, or a listing of the state's register properties may be obtained from the SHPO).

To identify properties eligible for inclusion in the National Register, National Register criteria can be applied, in consultation with the SHPO, to properties in the subarea where growth is expected to occur. Historic resources in the subarea may be identified by a variety of means, including a "windshield survey," researching the results of historical, archaeological and architectural surveys of the subarea by public and private groups or organizations, and direct examination of the subarea by historians, architects, and archaeologists. This inventory and analysis should focus on resources which are most likely to be affected by the proposed project. If the analyst finds an unlisted property within the subarea which might meet eligibility criteria, this information should be recorded on a National Register inventory/nomination form; this is necessary to determine eligibility and, thus, whether the potential for impact under this section is likely. (149) If properties included in, or eligible for inclusion in, the National Register are not identified in the area of possible impact, the analyst should so document. If such properties are identified, however, the analyst can determine whether the proposed project will have an effect upon them, and, if so, to what extent.

Step 2. Identify probable secondary impacts of the proposed WWTF on these properties.

To identify possible secondary impacts of the project, the analyst should consider all possible ways in which changes in population, economic growth, and land use may have beneficial or adverse effects on the quality of the historic, architectural, archaeological, or cultural character that quality the properties under the National Register criteria. (149) Probable ways in which changes induced by the construction of wastewater treatment facilities would affect properties of historic, architectural, archaeological, or cultural significance include: changes in the surrounding environment; changes of usage; intrusions which would be inconsistent with the properties or which would alter their setting; or actions which would make the property more "economically attractive" for new construction.

Further, induced impact depends on the nature and significance of the property and its protection from development pressures. The National Register description indicates whether the resource has national, state or local significance and also why it qualifies for listing. An inspection of the property and its surroundings, and an examination of local and use and zoning, should provide information sufficient to assess the likelihood of changes in the environment, as based on land use projections, and adverse effects on the property itself.

If, for example, an historic home of national significance is situated on a relatively small lot surrounded by acres of open space suitable for residential development and the proposed project will provide sewer service to that open land, it is highly likely that new development will occur. In this situation, this development will probably conflict with the rural setting and earlier architectural style of the historic property. If, on the other hand, the property is a church of exceptional architectural significance to the area, and is presently surrounded by single family dwellings, it is unlikely that sewer service through the area would change the setting or affect the usage of the church to any significant degree, given that the neighborhood will remain at roughly the same density.

If there are no projected impacts, the analysis may stop at this step.

Step 3. Determine the severity of the impact.

Advisory Council on Historic Preservation procedures include the following criteria of adverse effect: (149)

(a) Destruction or alteration of all or part of a property;

(b) Isolation from or alteration of its surrounding environment;

(c) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(d) Transfer of sale of a federally-owned property without adequate conditions or restrictions regarding preservation, maintenance, or use; and

(e) Neglect of a property resulting in its deterioration or destruction.

All of these are potential effects that could result from secondary impacts. Which impacts will actually occur at a specific property depend upon projected land uses, the rate of change of these uses, and the adequacy of protection given the site.

Projected land use changes, if expected in the area immediately surrounding the listed site, must be considered as to whether they will detract from the setting of the property itself. Increased economic activity in the project area might cause increases in traffic or access streets, making it more difficult to reach or necessitating construction; increases in the numbers and types of people who use the property could adversely affect it. Isolation by changed land use or difficult access could cause a decline in use and subsequent neglect of the property. The Advisory Council on Historic Preservation requires that one apply its "criteria of adverse effect" in consultation with the State Historic Preservation Officer. A list of names and addresses of SHPO's, along with criteria and procedures for nomination of a property to the National Register, is available in a booklet How to Complete National Register Inventory-Nomination Forms. (155) Consultation with local historic and/or archaeological societies in evaluating the significance of the cultural property and of possible impacts to it would also be useful at this stage. Local planners, university historians, archaeologists, and local architects can provide feedback on the effects of projected population, economic, and land use changes on the property so that the analyst can determine the degree of impact.

Step 4. Determine applicable state and local laws and ordinances.

In addition to compliance with Federal laws and regulations, state and local laws and ordinances and legal devices protecting or affecting areas of historic, architectural, archaeological, or cultural value must also be identified and followed. (Ordinances which permit historic zoning, transfer of development rights, or preservation easements may mitigate potential secondary impacts.)

Step 5. Make a map of the properties and areas of historic architectural, archaeological, or cultural values.

This map should be used to document and summarize the location and characteristics of all historic properties and facilities. Used in conjunction with growth projection maps (with and without the project) the analyst should have documentation adequate to support the initial finding of projected induced growth impact significance.

5.3.2 Second-Level Approach

The second-level approach is required only if significant adverse impacts have been identified.

Step 1. Before the following steps of this second-level approach are initiated, the analyst must proceed through the five first-level steps.

Step 2. Carry out consultation process - If it appears that significant adverse impacts may result from the project, primary data collection is essential to characterize property values and actions necessary to reduce or eliminate adverse effects. This data collection may require special expertise and could be time-consuming and expensive, depending upon the information needed. Other agencies or outside consultants may be brought in, particularly for such things as archaeological site and historic preservation data collection and analysis.

The consultation process required by and described in the Advisory Council procedures is quite extensive and involves on-site inspections by the SHPO, staff members, the Advisory Council, and other representatives of concerned national, state, and local governments and public and private organizations; public information meetings; and consideration of any "prudent and feasible" alternatives available to avoid and/or lessen adverse effects. Most of the burden for conducting these meetings and considering alternatives and ways to avoid or mitigate adverse effects rests with the SHPO and the Executive Director of the Advisory Council; thus, only in rare instances of extreme adverse effect would agency collection of primary source data on the property and impacts actually be required. When such information must be obtained by the user of this manual, qualified professionals should summarize data on the following characteristics:

- The setting of the property having historic, architectural, archaeological or cultural value. What types of land use about the property? What is the view of and view from the property? Are there surrounding or nearby land uses or activities related to or particularly compatible with the property? Are there particularly incompatible uses?
- Use of the property. For what purpose(s) is the property used? How often is it used? Is it open to the public? If so, when and is there a change? If not, who does use it? What kinds of people use it? -- family groups, tourists, students, professional researchers or scientists, artists?
- Accessibility of the property. How do users get to it? Are existing streets and parking facilities (if any) adequate? Is accessibility now a problem?
- Sensitivity of the property to environmental changes. Are materials sensitive to changes in temperature, humidity, or level of air pollution? Are there structures or instruments which are sensitive to noise or vibrations?

- State and local laws or ordinances. Is the property protected by any other statutes? (e.g., historic zone)

The above information may be obtained from on-site inspections of the property; contact with local historic and archaeological societies, curators or custodians of the property, other government agencies having jurisdiction (e.g., National Park Service); land-use maps, highway maps, USGS maps. Local historic or cultural societies should be consulted for any documents or material relating to the resource's history and use and relationship to the culture of the area, region, or country. If the resource is used by local or regional professionals, they should be consulted regarding the research potential of the property. If the resource is heavily used by the general public, questionnaires or on-the-spot interviews might be administered to gain an understanding not only of how the resource is used and perceived, but how users view potential changes in the property's surroudings, setting, or use.

State, local, or university historians, architects, or archaeologists provide consultation. State historical and archaeological societies or other larger historic preservation agencies sometimes can provide professional services. Regional offices of the National Park Service can recommend archaeologists and others who are engaged in such work. Regional offices of the NPS, under recent legislation, will be able to conduct services for other agencies in the identification, protection, and enhancement of historic and cultural properties. Until procedures are developed, agencies needing help should direct inquiries to the Director, Office of Archaeological and Historic Preservation, National Park Service, Department of the Interior, 18th and C Sts. NW, Washington, D.C. 20240; private assistance is also available.

Even though a property may be identified as being of historic, architectural, archaeological or cultural significance, it may still be subject to physical desecration or destruction. That is, a property may be placed on the National Register List through application of the required process; if, subsequently, the owner can demonstrate that only by new construction is there an economically feasible use for the property, it may be taken off the Register List. This usually happens as a result of a court suit. In this situation, impact may be minimized to some extent if a thorough documentation is made (measurements, pictures, etc.) of the property value in historic or cultural terms.

Based on information gathered by the analyst, a judgment is required on the extent to which significant properties are protected, given projected adverse developmental impacts.

6.0 SECONDARY IMPACTS ON AGRICULTURAL ENTERPRISE, ENERGY PRODUCTION AND CONSUMPTION, AND LAND VALUES

The provision of sewers to an agricultural area may be the factor which is sufficient to initiate development for nonagricultural uses, although sewer location decisions alone are typically not the only factor contributing to development. Potential changes in agricultural land use are, incidentally, addressed in environmental impact statement requirements where assessment of the impact of treatment works or plans must include estimates of adverse impact on agricultural production. (156)

A different pattern of urbanization following sewer facility development can also affect energy production and consumption. Major impact on energy consumption is due to changes in transportation and housing patterns, since these two activities typically account for over one-half of urban energy use. Housing pattern changes can affect energy consumption in a number of ways. For instance, shifts from detached single-family housing to high rise residential apartment units can significantly affect consumption, since high-rise apartments consume approximately 45% less energy per dwelling unit. (157) Better planning, clustering, and higher density development can reduce transportation-related energy use through reductions in per-trip energy use and shifts to more efficient forms of transportation. (157)

Sewer facility location, as one factor influencing patterns of development and urbanization, can also affect land values. The potential of higher density as an alternative use to current patterns of land use can significantly increase land values; to the extent that these alternative uses are motivated or enabled by the existence of sewer facilities, land value impact must be included as a secondary economic impact type.

Section 6.1 describes the approach to analysis of agricultural land use impacts, while Sections 6.2 and 6.3 similarly examine the secondary energy use and property value impacts from sewer facility development and location decisions.

6.1 Impact on Agriculture

An analysis of land use trends for agricultural and nonagricultural activities shows that, from a national perspective, total agricultural uses by category (cropland, grassland pasture and range, forest land, etc.) have not changed significantly in the last twenty years. However, irrigation, drainage and clearing have added three times as much land annually to the cropland as urbanization absorbs. (157) While cropland has not contracted, harvested acreage has apparently dropped significantly. (158) Nevertheless, farm mechanization, fertilization, and other gains in farm production efficiency have boosted yield per-acre and per farm employee enough that total output has kept pace with demand.

Given these national land use and agriculture productivity trends, one might initially conclude that pressures place upon agricultural land and farm operations by proposed WWTF construction won't influence the supply/demand situation in agricultural product markets. However, if one's analytical perspective is shifted to regional commodity markets and to developmental impacts on individual farm units, three entirely different developmental implications emerge.

First, farm produce is typically consumed, with seasonal variations, within a few hundred miles of the place of production in rural areas surrounding metropolitan consuming areas. Therefore, even if local markets are augmented by produce imported from other parts of the U.S., loss of local agricultural land to nonagricultural uses may contribute to price rises, due to added cost of transportation and refrigeration.

Second, increases in the value of agricultural land for alternative (nonagriculture) uses may be the result of a combination of technological developments in farm operations and development pressures. Although the application of newer, more efficient farming technology results in greater production per acre, it often requires a minimal farm size which is larger than many existing farm units. Therefore, farms must either expand or become less competitive than other, larger farm units which can effectively apply new technology. At the same time, land values may rise to the point where capital costs of expansion become prohibitive.

A survey of farms transferred during a five-year period (ending March 1, 1974) showed that, of these farms, (159)

> 70 percent of the transfers and 78 percent of the acreage transferred will probably continue in agricultural use. Eighteen percent of the acreage transferred was expected to become rural residences, six percent was expected to go into subdivisions, and about one percent into commercial or industrial development in the next five years.

However, it is important to note that in Pennsylvania about 25% or the farm real estate transfers were additions to existing farm operations. This is consistent with longer term trends in Pennsylvania, for in the period from 1950 to 1969, the number of farms declined by more than half, but the remaining farms increased by about 45% in average size. (159) However, on Long Island, an area undergoing tremendous urban pressures, farmland acreage in Suffolk County decreased from 123,000 acres in 1950 to 68,000 acres in 1972. This is typical of the increasing losses of agricultural land due to urban expansion and appreciation of land values. (160)

The third trend in agricultural land use follows from a set of economic factors which encourage concentration and/or taking land out of agricultural use. Specifically, where property taxes are based on "highest and best use," and not on existing (agricultural) use, taxes as a percentage of income may increase dramatically when the area becomes "ripe" for development. Also, increases in energy costs (which are significant farm costs) have multiple effects; not only have fuel (for machinery) and fertilizer costs increased, but their usage has become more important as farm operations have become more mechanized.

Thus, to the extent that wastewater treatment facilities encourage development (i.e., increase the value of farm land for alternative uses by permitting higher density development) and add to increasing farm operating costs, a number of important regional and local trends in agricultural land use and agricultural production may be accelerated. However, local land use policy could provide significant protection to discourage conversion of agricultural land to nonagricultural uses.

We can examine these agricultural impacts on the following three dimensions:

1. Operation Changes -- Local population pressures resulting from development in areas adjacent to farm property may have the following types of effects:

   - -- fertilizer, other supplies, machinery and equipment may be more readily available at less cost due to increased demand and reduced transportation costs per unit;
   - -- local supplies of capital and labor could be directed to competing opportunities in nearby developing areas, thereby increasing farm operating costs;
   - -- the market for farm products may become less centralized, thus increasing distribution costs;

-- the problem of operating any commercial enterprise--crime, pilferage, damage--may increase because of urbanization and the proximity of population growth.

2. Intensification -- Productivity gains may increase at a faster rate than inflation, costs of operation, and replacement costs. Nevertheless, it is likely that a combination of taxes, land valuation and various other costs of doing business will lead to more intensive use of the land, either by conversion of unused acreage to production, shifts to products with higher unit values, or both.

3. Conversion -- Finally, as noted above, individual farm units, under a combination of pressures, may eventually have higher present values to their owners in nonagricultural uses. That is, combined with shortages of sources of capital and increased risks due to reliance on special or single crops, owners may receive a greater return from some other form of land use, or as part of larger farms which can be more competitive.

6.1.1 First-Level Approach--Agriculture

1. Is farming a significant activity in the subarea and are agricultural products significant?

Utilizing maps of land use patterns in the subarea (Sections 2.2.1 through 2.3) the analyst should tabulate and summarize acreage in different land uses and the percentage of total acreage in the area found in each use. This display and tabular summary should provide the following detail (in acreage and percent of total) regarding agricultural land use:

- cropland and available grassland pasture and range
- cropland by subcategory; harvested, crop failure, cultivated summer fallow, and soil improvement and idle cropland
- harvest cropland by major types of crops produced
- agricultural land by soil classification type
- employment in the area in agricultural activity versus other job classifications

Data on land use by category are found in the following sources:

- The 1974 Census of Agriculture provides state-level data on:
  - number of farms
  - use of land
  - types and value of product

- The Soil Conservation Service publishes soil classification data for soil conservation districts in all states (same as used in sedimentation analysis).
- County and multicounty development plans may already include analysis of other secondary source information in convenient form and at sufficient depth for this analysis.
- The U.S. Census of Employment provides data at the county level on employment in agricultural and other industrial categories.
- The Economic Research Service, U.S. Department of Agriculture publishes reports on current situations in various commodity markets.
- Many State Departments of Agriculture and county agents can provide detailed information.

The analyst should examine these data on existing agricultural land use patterns and determine if there is significant farming activity in the area. The definition of "significant" must, of necessity, be judgmental. In terms of actual land use allocated to cropland, the user can use as a benchmark the average for all land in crop use as a percentage of all U.S. property. Thus, if 21% or more of the land in the area is cropland, agriculture could be considered "significant."

A second measure of significance uses the market characteristics for locally produced crops. That is, if the crops are consumed locally, one can conclude that, regardless of the amount of land in agricultural use, agricultural activity is important in terms of availability and cost of staple food products in this local farm commodity market.

Finally, soil classification of harvested lands should be examined in order to determine potential productivity. If soil quality is known to be high, and therefore highly productive in farm uses, this attribute should be considered in assessing the significance of agricultural activity.

If, based on the above information, the use of the manual concludes that farming is not a significant activity in the subarea and that the agricultural products grown in the subarea are not significant then it is likely that there will be no significant impact on agricultural land use if the proposed WWTF is constructed. If, on the other hand, agricultural activity is judged to be significant, then the second-level approach to assessment of agricultural impacts should be applied.

6.1.2 Second-Level Approach--Agriculture

The first step of this approach is to determine whether there actually is a significant level of farming activity in the subarea, and whether there are significant agricultural products grown in the subarea. The first-level approach outlines how this can be done. If one can conclude that (1) farming activity is not significant and (2) no significant agricultural products are grown in the subarea, then this should be sufficient to conclude that there will be no significant secondary impact on agricultural land use.

If either or both conditions for significance exist, the second-level analysis is applied to determine:

- historical stability of agricultural use of land
- stability of farm units
- insulation of farm units from development pressures

The first two attributes can be arranged to generate a typology of relative stability of agriculture land use as follows:

		Historical Stability of Agricultural Land Use in the Subarea	
		Unstable	Stable
Stability of Farm Units in the Subarea	Unstable	A	B
	Stable	C	D

The extent of legal and other devices in existence which insulate agricultural property from external pressures can alter these historically stable or unstable trends in land use in the future.

It is uncertain whether, given the conditions stated in Box A, any insulation from development pressures could protect agricultural land from development pressures. If there are no effective protective devices, it is virtually certain that impact will be significant; the extent of this impact due to the proposed project would then depend upon the amount of development directed to farmland which would not otherwise have occurred there. This judgment may be determined from the set of maps developed in Chapter 2 (Sections 2.21 through 2.3).

At the other extreme (Box D) are conditions under which there would probably be little impact on agricultural lands and farms, especially if currently stable conditions are reinforced by strong legislation which protects farm use from development pressures.

Probably the next most stable situation is Box B, where pressures for concentration lead to transfers of farmland to create larger farms, thereby decreasing the number of farms but maintaining the total amount of land in agricultural use. In this context, legislative protection of agricultural lands could effectively protect against future long-run development pressures.

Instability in land usage for agricultural purposes coupled with stability of individual farm units (as represented by Box C) could be affected by the implementation of measures to insulate agricultural use of the land; the effectiveness of such measures would depend upon the type of development pressures. For example, it is common to find the sale of several small housing lots by a farmer who is maintaining back acreage for agricultural purposes. In this situation, availability of sewers could induce development of the agricultural land; such development could be discouraged entirely or at least delayed through effective legislation which insulated agricultural use of the farm land.

Given these situations, we turn to methods for determining the stability of agricultural land in the subarea, the stability of the farm units in the subarea, the measures available to protect agricultural lands and farms from developmental pressures, and the extent to which WWTFs would encourage development of agricultural lands.

In order to determine the stability of agricultural land use in the subarea, it is necessary to assess the economic pressures that may have produced significant shifts from agricultural to nonagricultural use. Data from the Economic Research Service, U.S. Department of Agriculture, and the U.S. Census of Agriculture, state agriculture agencies, local farm interest groups, and multicounty or regional planning bodies can usually provide information to help answer this question.

The information should be examined from two perspectives:

- Trends in agriculture concentration: what is the pattern of land transfers between farm units?
- Trends in loss of agricultural land: what is the pattern of transfers to nonagricultural use?

The analyst should examine these trends (rates of changes) and determine whether agriculture use in the subarea has been stable, declining, or growing.

To determine whether farm units are stable, the analyst must examine historical trend data on the number of farm units operating in the subarea. A significant historical trend of shifts out of agricultural land use could indicate that the farm industry is not stable, although this trend could result from other factors. Therefore, an independent examination of farm operations should assist in formulating an initial impact judgment. That is, if local farm units tend to show signs of health (survival) in terms of revenues, profitability, and capitalization, then the proposed WWTF may have little if any immediate impact on agricultural land use; conversely, in a declining agricultural area, secondary impacts could be more immediate and significant.

The Economic Research Service publishes analyses of farm operations which provide national industry benchmark data. (161) (162) Local data on the agricultural industry may be available from State and County Agricultural Agencies; State Agricultural Schools should also be of assistance in determining historical trends.

The extent to which farm land may be affected can be determined by comparing the maps of probable development, with and without the proposed WWTF. Since sewers tend to concentrate the population at higher densities, it is possible, given a sewer alignment not in an agricultural area, that there will be less potential agricultural impact with the proposed facilities.

Finally, it is necessary to determine what measures exist to protect agricultural lands from development pressures. Public policy considerations in some locales have culminated in local tax, zoning, or other actions which serve to protect or "insulate" farms from some of the pressures for intensification and conversion associated with local development. The analysis should, therefore, include an investigation of applicable statutes or ordinances, a determination of their application, and a finding as to their effectiveness relative to the development pressures identified.

The Economic Research Service publishes surveys which should assist in this regard. (163) (164) Data from these surveys should be updated and checked through discussion with personnel in state departments of agriculture or local offices of Federal agencies. These discussions should focus on recent changes in state zoning or differential assessment laws. Moreover, the user of the manual should determine if statutes (other than zoning/ assessment) intended to protect farms from development pressures might have been recently enacted or are presently under consideration.

A particular type of technique that should be identified and analyzed, if appropriate, is generally titled "less-than-fee-simple." The technique may be implemented in a variety of forms, but basically combines the "assessed tax values under farm use" features of differential assessment laws with sale of title to development rights to government. These combined features are intended to reduce short-term pressures, such as heavy taxation, and minimize long-term incentives to sell agricultural land for nonagricultural use. The underlying principal is that, by providing immediate opportunity to sell nonagricultural development rights to the government at a higher value while still maintaining the land in farm use, the farmer should receive nonagricultural value for his land while maintaining it in its present use. Examples of this and other techniques have been described in various publications. (163,164,165,166,167,168,169)

In summary, this second-level analysis requires that the analyst collect data and conduct analyses which will determine the stability of agricultural land use, stability of farm units, development pressures focused on the agricultural lands by proposed projects, and effectiveness of available legislation which could insulate agricultural land from development for nonagricultural purposes. On the basis of these analyses, the user should develop a reasoned judgment regarding potential agricultural impact of induced development.

6.2 Impact on Demand for Energy

Interest in existing patterns of land use and land use planning issues has increased among Federal, state, and local officials because of recognition that land use patterns, housing location and density, and transportation system configurations directly affect levels of energy consumption. Conversely, changes in costs and availability of energy can affect consumption of energy and thereby affect land use patterns and transportation systems.

The analysis approach developed in the following subsections is designed to assist the analyst in identifying WWTF-induced land use implications for energy demand. First, an examination of historic patterns of energy use focuses on the implications of these historic patterns for future energy demand. Next, the identification of the major sewer-induced effects which could alter these historic energy use patterns is made. Third, a specific series of data collection and analysis steps is suggested to identify the magnitude of these sewer-induced shifts in energy demand.

6.2.1 National Patterns of Energy Availability and Use

Future demand or consumption of energy depends largely on historic use patterns and availability by type of energy source, the form of use, the sectors of energy consumption, and price. This section examines national energy data in order to provide some context for consideration of land use change impacts on energy use in Section 6.2.2.

Figure 6.1 summarizes the approximate flow of energy through the economy in 1971. (170) The figure identifies, for one period of time, the pattern of demand by type of energy resource, broken down as follows:

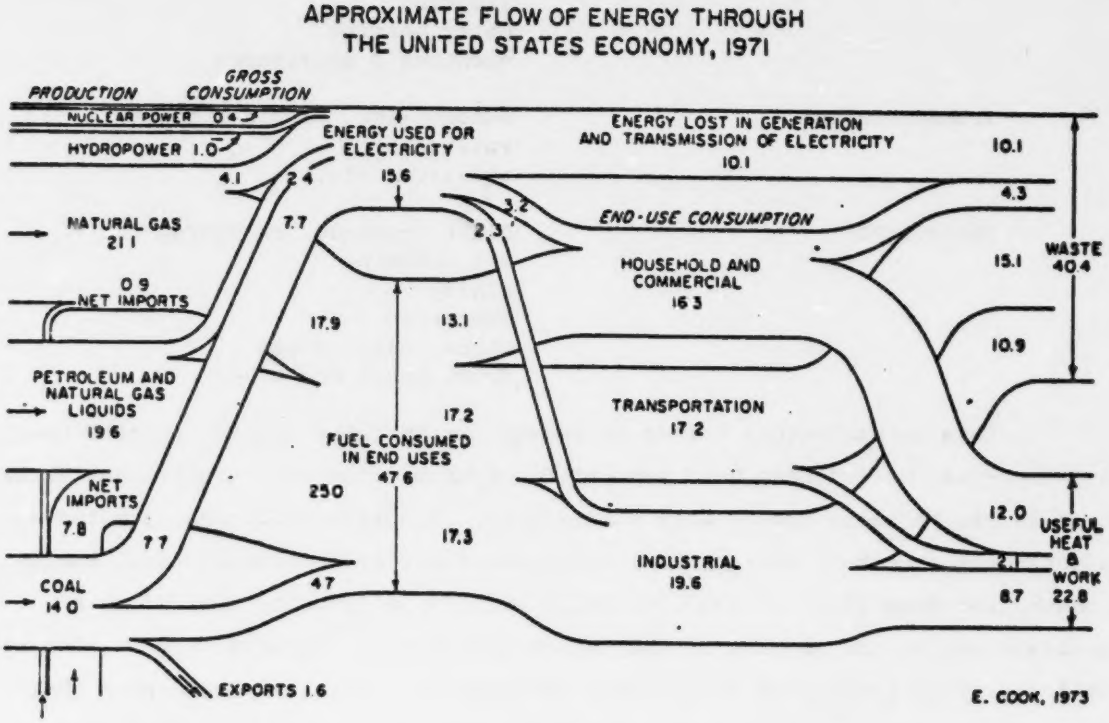
- nuclear power
- hydropower
- natural gas
- petroleum and natural gas liquids
- coal

Moreover, the figure shows the relative importance of energy resources by form of energy use: generation of electricity versus consumed in end uses. Regardless of intended productive use (electricity generation or other end-use consumption), significant waste occurs. Overall, the table shows that 40.4% of total energy production is wasted, with the greatest "inefficiency" occuring in generation and transmission of electricity.

Energy source-use information is given an historical perspective when one analyzes consumption by energy source and consumption by form of use. In the period from 1920-1970, a significant trend emerges from the analysis of longitudinal data. Coal drops tremendously in significance relative to other types of energy sources: from supplying over 78% of total energy sources (1920) to only 20% (1970), with petroleum and natural gas increasing from 13.5% and 4.2%, respectively, to 43% and 32.8% (1970), respectively, of total energy consumed. (171)

The three types of end-use sectors identified in Figure 6.1 (household and commercial, transportation, and industrial) may be grouped as follows, in terms of specific types of energy users:

Figure 6.1



Source: "Statement of Earl Cook," The Impact of Growth on the Environment. (170)

Household and Commercial	space heating air conditioning cooking lighting water heating machines & appliances
Transportation	automobiles, trucks & buses railroads aviation, etc.
Industrial	blast furnaces, smelters oil refining mining chemicals stone, clay, glass food, paper and other

Data on historical trends in energy use by these end-use sectors over a twenty-year period have been tabulated. Probably the most significant variation in use patterns occurs with electricity. Electric utilities, treated as a consuming sector of energy, have increased their proportion of total energy consumption from 15.1% in 1950, to 24.7% in 1970 (a large portion of this increase was at the expense of the industrial sector). Examination of electric utility energy production by ultimate consumer of electricity indicates that the largest increase is in households and commercial, which increased from 29.5% of electric utility energy consumption in 1950 to 34.3% in 1970. (171)

6.2.2 Sewer-Induced Land Use Change and Energy Use Patterns

The analysis of energy implications of land use change is focused on shifts in transportation patterns, housing location and population density for two reasons. Changes in transportation and residential energy use have potentially the greatest impact on efficiency of energy usage; residential units are a major consumer of electricity which has roughly an efficiency of 31% (or a 69% wastage), and on fuels for transportation, which have an efficiency of 25% (or 75% inefficiency). (Efficiency of these end uses compare with roughly 75% efficiency of fuel use for other applications. (172) Second, as shown in Figure 6.2 (173) transportation and space heating uses for energy are the largest components of total energy use.

A review of relevant literature indicates that both transportation and residential energy uses are affected by housing types and locations. High-rise apartments, for instance, are estimated to consume 45% less energy

Figure 6.2

ENERGY CONSUMPTION

	Percent of Total
Transportation (fuel; excludes lubes and greases)	24.9%
Space heating (residential, commercial)	17.9
Process steam* (industrial)	16.7
Direct heat* (industrial)	11.5
Electric drive (industrial)	7.9
Feedstocks, raw materials (commercial, industrial, transportation)	5.5
Water heating (residential, commercial)	4.0
Air conditioning (residential, commercial)	2.5
Refrigeration (residential, commercial)	2.2
Lighting (residential, commercial)	1.5
Cooking (residential, commercial)	1.3
Electrolytic processes (industrial)	1.2
TOTAL	97.1%

Source: Patterns of Energy Consumption in the United States. (173)

per unit for all residential purposes than detached single-family houses. (4) These savings stem mainly from energy use for residential heating and cooling; the smaller the units, the greater the insulation, and the greater number of "common walls," the less energy per unit used. Further, high-rise apartments also "concentrate" a large number of persons nearer their places of employment, making it possible to have less vehicle miles traveled per day and to shift to higher density forms of mass transportation made feasible by higher density. (174)

6.2.3 First/Second-Level Assessment of Energy Impact

Energy impact assessment begins with definition of current energy use in end-use sectors in the subarea. Data for this purpose may be obtained from a variety of sources, including:

- county government, or multicounty planning bodies,
- private trade associations, including retailers and wholesalers of gasoline, natural gas, and other petroleum products,
- state departments of business, industrial, or economic development, and
- energy user trade associations, such as Chambers of Commerce and industrial trade associations.

If local data are not available, aggregate energy use data, including that presented in Section 6.2.1, may be used.

Next, one of two approaches should be used to compare the energy use implications with and without existence of the waste water treatment facility.

Alternate Development Patterns - This approach consists of comparing the previously determined patterns of development, with and without existence of the WWTF (Section 2.2.1 through 2.3), to one of five settlement patterns, with which energy consumption can be associated. (175) This allows the analyst to determine the differences in energy consumption from the sewer-induced land use changes. This approach should be used when the scale of the proposed WWTF is large enough to affect such patterns of development.

The five distinct patterns of development which should be considered are:

A. Dense center
B. Transit-oriented
C. Wedges and corridors

D. Beltway-oriented

E. Sprawl

The housing locations, density patterns, and transportation configurations which characterize each of these patterns are as follows:

A. Dense Center

This type of development assumes that all added households and employment will be concentrated in the urban center and that most new residential construction will be high-rise, with some garden-type apartments. It assumes that the major mode of transportation for daily commuting will be some form of rapid transportation.

B. Transit-Oriented

The emphasis in this development pattern is on a mass transportation system which goes beyond the urban core. Most new households and employment will be located in areas convenient to a mass transportation system. Housing will consist of a mix of high-rise, and garden-type apartments, with a limited number of duplex or row-house units.

C. Wedges and Corridors

The emphasis in this urban pattern of development is on radial transportation routes from an urban center and development along these corridors. In between these corridors will be wedges of open land without future development. The type of housing will be a mix of all types, with high density units toward the urban center.

D. Beltway-Oriented

The shape of this development pattern is dictated by a beltway; e.g., a circumferential expressway that rings the urban area. New households and employment are concentrated in vacant areas adjacent to the beltway. New housing units constructed in this development pattern will be a mix, with high-rise and garden-type apartments at points of high accessibility, and row-houses and single-family units on land further from the urban center and the beltway.

E. Sprawl

The addition of households is assumed to develop in low density, largely single-family units, with employment concentrated in the urban center (office use), but also around crossroads or circumferential routes and in smaller shopping areas. High accessibility via the use of the automobile is characteristic of this development pattern.

The population distribution projections with and without the proposed WWTF are unlikely to be the same. For instance, the provision of sewers may provide a density which makes rapid transportation feasible. Thus, a present dense center may develop toward pattern "B" with the WWTF, instead of pattern "E,", without the WWTF. Relative energy use implications of these alternative patterns of development can be derived using data from Figure 6.3. (175)

Population Growth and Housing Density - The second method for determining energy consumption uses data generated in Chapter 2, where an estimate was made of the number of different types of dwelling units with and without WWTF. If more local and reliable data is not available, the following BTU values associated with different types of units shown in Figure 6.4 may be used to determine total energy usage. (175) For example, assume that the data generated for number of units by type is as follows:

Type of Dwelling Unit	No. of Units by Type	Average BTU/Yr/ Unit ($\times 10^6$)	Total BTU/Yr for Type of Unit ($\times 10^{12}$)
Without WWTF			
High-Rise	3,950	487	1.92
Garden Apartment	3,975	501	1.99
Town Houses	1,650	511	.84
Single-Family	555	528	.29
	10,125		5.04
With WWTF			
High-Rise	5,375	487	2.62
Garden Apartment	3,150	401	1.58
Town Houses	1,600	511	.82
Single-Family	--	528	--
	10,125		5.02

The difference in energy consumption for the different type of housing development due to the WWTF is 20×10^9 BTU/Yr.

Figure 6.3

Average Per Capita Energy Consumption by Alternative Development Patterns (In 10^6 Btu/Yr.)

Pattern of Development	Base	A "Dense Center"	B "Transit-Oriented"	C "Wedges and Corridors"	D "Beltway-Oriented"	E "Sprawl"
Consumption by Sector						
Residential	53					
Increment		18	19	22	22	24
Total, Forecast Year		71	72	75	75.	77
Commercial/Industrial/	35					
Increment		16	16	16	16	16
Total, Forecast Year		51	51	51	51	51
Transportation						
Automobile	26					
Increment		7	7	12	10	14
Total, Forecast Year		33	33	38	36	40
Mass Transportation,[1]	1					
Increment		2	2	2	2	2
Total, Forecast Year		3	3	3	3	3
Total	115					
Increment		43	44	52	50	56
Total, Forecast Year		158	159	167	165	171

Source: Adapted from data of Real Estate Research Corporation, as presented in "Energy and Land Use: Analysis of Alternative Development Patterns," Environmental Comments. (175)

---

[1] The per capita energy consumption for each alternative development pattern assumes a transportation modal split between automobile transportation and mass transportation. If no mass transportation is to be provided, one must increase the energy used for transportation by the most likely alternative, the automobile, by adding 11 x 10^6 Btu/Yr. to the total. (This actually adds 14 x 10^6 and subtracts 3 x 10^6, the mass transportation's use.) For example, if in "C" there will be no transportation, the total is 167 + 11 = 178 (x 10^6 Btu) per person per year.

Figure 6.4

Average Energy Consumption By Alternative Development (In 10^6 Btu/Yr.)

Type of Housing Unit	Base	High-Rise	Garden	Row	Single
Consumption by Sector					
Residential	165				
Increment		58	64	70	76
Total		223	229	235	241
Commercial/Industrial/ Institutional	110				
Increment		49	49	49	49
Total		159	159	159	159
Transportation, Automobile	74				
Increment		21	29	33	44
Total		95	103	107	118
Mass Transportation[1]	21				
Increment		8	8	8	8
Total		10	10	10	10
Total	351				
Increment		136	150	160	177
Total		487	501	511	578

Source: Adapted from data of Real Estate Research Corporation, as presented in "Energy and Land Use: Analysis of Alternative Development Patterns," Environmental Comments (175)

---

[1] The per capita energy consumption for each alternative development patterns assumes a transportation model split between automobile transportation and mass transportation. If no mass transportation is to be provided, one must increase the energy used for transportation by the most likely alternative.

For purposes of comparison, on a daily basis:

10^{12} Btu/yr is equal to:	470 barrels/day of oil
	2,660,000 cubic feet/day of gas
	130 tons/day of coal

6.3 Impacts on Property Values

The value of property is determined to a great extent by the uses which can be made of the property. These uses, in turn, are often limited by the physical characteristics of the property, its location, and/or imposed restrictions (e.g., zoning). The provision of public sewer service to property obviates not only the need to have certain soil conditions present to "handle" septic seepage but also the common legal "health and welfare" basis for large minimum lot zoning. The result is an increased potential use of the property, which is reflected in a higher potential income flow from the property. Capitalization of this income stream is shown in increased property values.

The only study which has thoroughly examined this interrelationship over an extended time period (176) concludes that: (1) sewered land values averaged four times the value of unsewered property; and (2) the average annual percentage increase in the value of land in an area which is not yet accessible to sewers is twice the annual percentage value increase of already-sewered property. Values are apparently not only correlated with sewer location, but changes (increases) in value also occur faster prior to actual sewer service, in anticipation of increased value that will result from sewer accessibility. This anticipation of increased land values based on potential availability of sewers, and not just on potential development, is probably a more realistic assessment of circumstances which often occur in subareas undergoing development.

The importance of sewer facility location to various land use decisions depends, of course, upon the type of proposed use local factors such as vacant land availability, accessability, and previous sewering in the immediate vicinity.

The growth projections developed in Chapter 2.0 include estimates of the spatial allocation and level of residential, commercial, and industrial demand for land in the study area. The main question for analysis here is: "Who gains and how much is gained from induced incremental changes in land value resulting from sewer investments?"

The analysis requires, in general, that the induced growth patterns be translated into land value changes and that the beneficiaries of these changes in value be identified. (Note that Section 6.1 examines the potential negative impacts of land value changes on farm operations; here we include an analysis of farmland value changes among many other classifications of land use as part of the assessment of positive--e.g., value to the owner--secondary impacts of induced growth.)

6.3.1 First/Second-Level Approach--Land Value Changes

The same analysis approach is used for both first and second levels, the only difference being the depth of second-level analysis required because of the size of the proposed WWTF.

Analysis of land value changes requires that the following be known about the impact area:

- location of treatment facilities, trunk sewers, and patterns of induced residential, commercial, and industrial growth resulting therefrom;
- limitations on trunk capacity which may affect adjacent land use;
- local land use and zoning restrictions which may affect adjacent land use;
- ownership patterns of property adjacent to new trunk sewer service area;
- the current market value of sewered land in adjacent areas being utilized for residential, commercial, and industrial purposes.

The basic approach is to determine the most likely permissible uses of individual parcels in newly sewered areas and, given the pattern of ownership transfers since sewer planning commenced, to determine who will share in the incremental value attributed to these parcels (the difference between value in use prior to the start of sewer planning and the value in ultimate, permissible use as measured by current market value of nearby sewered property in similar uses).

Projections of residential, commercial, and industrial development patterns in Chapter 2.0 include a map of facility and trunk sewer locations, as well as project land uses for the study area. These uses are consistent with limitations on trunk capacities and local land use and zoning restrictions.

The analyst should prepare separate map overlays which, for the same study area, identify ownership patterns of vacant land at two points in time: 1) one year prior to initiation of planning for the treatment facility being examined; and 2) presently. These two overlays should be used to identify patterns of ownership change over the period of study. Where ownership has changed, the analyst should determine the patterns of change. That is, have transfers been made among individuals or from long-time owners to development interests? Are a few buyers particularly active? Does ownership transfer activity occur mainly along proposed sewer trunkline routes, or is it more general throughout the area? Is ownership of contiguous parcels becoming more concentrated?

The analyst should identify interests (real estate, brokers and bankers) which have been active in the prospective WWTF service area and solicit their views on the patterns of land transfer and appreciation occurring throughout the area to buttress the comparative analysis above.

The results of these analyses should enable the analyst to characterize the pattern of land value changes which anticipate trunk sewer installation and to determine if beneficiaries tend to be original land owners or development interests with perspective insight and capital necessary to anticipate and capture land use value increases due to sewer installations.

In order to determine the increment to value from sewer investment, (regardless of owernship patterns and/or changes) in the long term, the analyst should identify portions of the study area which are presently sewered, but have adjacent vacant land. A number of sewer-adjacent areas should be selected so that, given zoning and other constraints, the areas are analogous to the area of study in terms of eligible residential, commercial, and industrial uses. Discussions with brokers and bankers and reference to secondary sources of data on land transfers should establish values in these areas. Finally, the analyst should compare values along the proposed trunk routes with these other values to define expected percentage increases in value which might be expected for the soon-to-be sewered property. Comparison of the "analogous area" land values to values one year prior to the start of planning and present values in the nonsewered area should be made.

In many communities which do not have existing sewer service, it will not be possible to determine an "analogous area," and the following questions must be answered using best available data. The comparison of these three (two) values provides the basis for answering the following two questions (which can be applied, respectively, to residential and industrial uses):

- If the proposed treatment facility/sewer project were in existence today, what would have been the likely percentage increase in value to "original owners?"
- If the proposed facility were in existence today, what would have been the likely percentage increase in value to "anticipatory owners?"

The key underlying assumption of this analysis is that unsewered land values will consistently lag sewered values and that, over some period of time, starting prior to actual construction, a rapid appreciation of property values will occur, reflecting the savings from alternative means of waste disposal and potential increases in the use of the property. Therefore, a comparison of specific parcels of land at two points in time, compared to a third value (current sewered land), can indicate expected percentage value increases expected to accrue to newly sewered property.

The impact estimate is derived in terms of percentage increase rather than absolute (dollar) increment to nonsewered value largely for reasons of practicality. That is, it would require a major assessment task to attach values to all property (nonsewered and sewered) prior to and after construction. The percentage increase, in contrast, uses a representative sample of properties to develop a range of representative percentage increases for different types of property in different uses.

REFERENCES

Chapter 1

1. P.L. 91-190, 42 USC 4321-4347, January 1, 1970.

2. U.S. Environmental Protection Agency, "Preparation of Environmental Impact Statements," 40 CFR 6.304(C)(3)

3. "Consideration of Secondary Environmental Effects on the Construction Grants Process," Program Guidance Memo #50. U.S. Environmental Protection Agency, June, 1975.

4. Environmental Quality, The Fifth Annual Report of the Council on Environmental Quality, December, 1974.

5. Environmental Quality, The Sixth Annual Report of the Council on Environmental Quality, December, 1975.

6. Binkley, Clark et.al., Interceptor Sewers and Urban Sprawl, Lexington Books, 1975.

7. U.S. Environmental Protection Agency, Secondary Impacts of Transportation and Wastewater Investments: Review and Bibliography, EPA-600/5-75-002, January, 1975.

8. See Milgram, Grace, The City Expands, A Study of the Conversion of Land From Rural to Urban Use, University of Pennsylvania, 1967; Jeffrey Stansbury, "Suburban Growth--A Case Study," Population Bulletin, Population Reference Bureau, April 1972; and Metropolitan Washington, D.C. Council of Governments, Analysis of the Joint Interactions of Water Supply, Public Policy, and Land Development Patterns in an Expanding Metropolitan Area, Office of Water Resources Research, U.S. Department of Interior, September, 1973.

9. U.S. Water Resource Council, 1972 OBERS Projections, Regional Economic Activity in the U.S. Series E Population, Washington, D.C., 1974.

10. See for example, Chapin F. Stuart, Urban Land Use Planning, University of Illinois Press, Urbana, 1965, pp. 15-21 for a discussion of various space organization concepts such as "sectors."

11. Page, Alfred N., and Warren R. Seyfried, ed., Urban Analysis: Readings in Housing and Urban Development, Scott, Foresman and Company, Glenview, 21, 1970.

12. Peter A. Morrison, Demographic Information for Cities: A Manual for Estimating and Projecting Local Population Characteristics, RAND Corporation, R-618-HUD, June, 1971.

13. David J. Bjornstad *et.al.*, "State Population Projections: A Comparative Review of National Series and their Practical Usefulness," Oak Ridge National Laboratory, February, 1975.

14. *Population Estimates and Projections, Series II*, Series P-25, No. 601, U.S. Department of Commerce, Bureau of Census, October, 1975.

15. *Employment and Training Report of the President*, U.S. Department of Labor, 1976.

16. As an example of a similar approach see Heightchew, Robert E., "Countywide Land Use Forecasts," *Journal of the Urban Planning and Development Division*, ASCE, Vol. 101, NO. UP2, November, 1975.

17. Stone, Ralph, and Smallwood, Herbert, *Intermedia Aspects of Air and Water Pollution Control*, U.S. Environmental Protection Agency Report 600/5-73-003, August, 1973.

18. Bower, Blair T., and Basta, Daniel J., *Residual-Environmental Quality Management: Applying the Concept*, Johns Hopkins University Center for Metropolitan Planning and Research, Baltimore, Maryland, October, 1973.

19. Paik, Inja K., Harrington, John Jr., and McElrow, F.W., *The Integrated Multi-Media Pollution Model*, U.S. Environmental Protection Agency Report 600/5-74-020, February 1974.

20. Reiquam, Howard; Dee, Norbert, and Choi, Paul, *Development of Cross-Media Evaluation Methodology*, Vols. I and II, Battelle, Columbus, Ohio, January 1974.

21. U.S. Environmental Protection Agency, "Preparation of Environmental Impact Statements," 40 CFR 6.

22. *Residential Stormwater Management*, joint publication at Urban Land Institute, American Society of Civil Engineers and NANB, 1975.

23. Linsley, Ray K., Jr.; Kohler, Max A.; and Paulhus, Joseph L.H., *Hydrology for Engineers*, McGraw-Hill, New York, 1958.

24. *Design and Construction of Sanitary and Storm Sewers*, ASCE Manual No. 37, ASCE, New York, 1970.

25. *Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years*, Technical Paper No. 40, U.S. Department of Commerce, Weather Bureau, 1961.

26. Areawide Assessment Procedures Manual, U.S. Environmental Protection Agency Report 600/9-76-014, July 1976.

27. Lager, John A., *et.al.*, *Development and Application of a Simplified Stormwater Management Model*, U.S. Environmental Protection Agency Report 600/2-76-218, August 1976.

28. Urban Hydrology for Small Watersheds, Technical Release No. 55, U.S. Department of Agriculture, Soil Conservation Service, January 1975.

29. Thurow, Charles; Toner, William; and Erley, Duncan, "Controlling Erosion," Performance Controls for Sensitive Lands, U.S. Environmental Protection Agency Report 600/5-75-005, March 1975.

30. Bhutani, Jognider, et.al., "History of Sediment-Loss Equations," Impact of Hydrologic Modifications on Water Quality, U.S. Environmental Protection Agency Report 600/2-75-007, April 1975.

31. Sedimentation, SCS National Engineering Handbook, U.S. Department of Agriculture, Soil Conservation Service, March 1968.

32. Michigan's Soil Erosion and Sediment Control Guidebook, Michigan Department of Natural Resources, Lansing, Michigan, February 1975.

33. Erosion and Sediment Control Handbook, Fairfax County Board of Supervisors, Fairfax Co., Virginia, 1974.

34. Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas, U.S. Department of Agriculture, Soil Conservation Service, College Park, Maryland, July 1975.

35. Colston, Newton V., Characterization and Treatment of Urban Land Runoff, U.S. Environmental Protection Agency Report 670/2-74-096, December 1974.

36. Interrelationships of Land Use Planning and Control to Water Quality Management Planning, Alan M. Voorhees & Associates, EPA Contract No. 68-01-0750, Washington, D.C., April 1973.

37. A Multi-Phasic Component Study to Predict Storm Water Pollution from Urban Areas, U.S. Department of Interior, Office of Water Resources Research, 1970.

38. Murray, Richard C. and Reeves, E. Bodette, Estimated Use of Water in the United States in 1970, Geological Survey Circular 676, U.S. Department of Interior, 1972.

39. Miller, David W.; Dluca, Frank A.; and Tessier, Thomas L., Ground Water Contamination in the Northeast States, U.S. Environmental Protection Agency Report 660/2-72-056, June 1974.

40. Our Land and Water Resources: Current and Prospective Supplies and Uses, Miscellaneous Publication No. 1290, U.S. Department of Agriculture, Economic Research Service, May 1974.

41. Ridker, Ronald G., "Future Water Needs and Supplies, With a Note on Land Use," Population, Resources and the Environment, Vol. III, Ridker, Ronald G., ed., Commission on Population Growth and the American Future, 1972.

42. McBride, Lawrence, "Arizona's Coming Dilemma: Water Supply and Population Growth," Ecology Law Quarterly, Vol. 2, No. 2, Spring 1972.

43. Hirshleifer, Jack; deHaven, James C., and Milliman, Jerome W., "Overdraft and Salt-Water Intrusion," Water Supply, University of Chicago Press, Chicago, 1960.

44. Kneese, Allen V. and Bower, Blair T., Managing Water Quality: Economics, Technology, Institutions, Johns Hopkins Press, Baltimore, 1968.

45. "Houston Subsidence: Rain Brings Action," Engineering News Record, July 17, 1975.

46. Eschman, Donald F., and Marcus, Melvin G., "The Geologic and Topographic Setting of Cities," Urbanization and Environment, Detwyler, Thomas R., et.al., Duxbury Press, Belmont, California, 1972.

47. Library of Congress, "Safe Drinking Water," Environmental Protection Affairs of the Ninety-Third Congress, U.S. Congress, 94th, 1st, Senate, Committee on Public Works, February 1975.

48. Clear Air Amendments of 1970, PL 91-604.

49. 40 CFR 50, National Planning and Secondary Ambient Air Quality Standards.

50. U.S. Environmental Protection Agency, Guidelines for Air Quality Maintenance Planning and Analysis (13 volumes), Research Triangle Park, North Carolina, 1974.

51. 40 CFR 52, Approval and Promulgation of Implementation Plans.

52. 40 CFR 51, Requirements for Preparation, Adoption and Submittal of Implementation Plans.

53. 40 CFR 51.12,Control Strategy General.

54. Argonne National Laboratory, Air Quality Analysis Workshop Manual, EPA 450/3-075-080A U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 1975.

55. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 2nd edition, third printing with supplements 1-5, AP-42, Research Triangle Park, North Carolina, 27711.

56. Larsen, Ralph I., "An Air Quality Data Analysis System for Interrelating Effects, Standards, and Needed Source Reductions - Part 2," Journal of Air Pollution Control Association, 24:551, June 1974.

57. Schultz, T.J., and McMahon, N.M., Noise Assessment Guidelines, U.S. Department of Housing and Urban Development, August 1971.

58. U.S. Environmental Protection Agency, First Report on Status and Progress of Noise Research and Control Programs in the Federal Government, EPA 550/9-75-023, June 1975.

59. U.S. Environmental Protection Agency, Public Health and Welfare Criteria for Noise, EPA 550/9-73-002, July 1973.

60. "Tiber Island Condominium, et.al, v. Washington Metropolitan Area Transit Authority," D.D.C. Civil Action No. 74-947.

61. Federal Highway Administration, Federal Highway Progress Manual, V. 7, Ch. 7, Sec. 3, "Procedures for Abatement of Highway Traffic Noise and Construction Noise, May 14, 1976.

62. U.S. Department of Housing and Urban Development, Noise Abatement and Control: Standards for New Construction, Department Circular 1390.2.

63. U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety, EPA 550/9-74-004, March 1974.

64. __________, First Report on Status and Progress of Noise and Control Programs in the Federal Government, June 1975.

65. __________, State and Municipal Control Ordinances, 1973-1974, EPA Report 550/9-76-006, January 1976.

66. Peterson, A.P.G., and Gross, Ervin, Jr., Handbook of Noise Measurement General Radio Company, West Concord, Massachusetts, 1967.

67. Federal Highway Administration, Federal Highway Program Manual, V. 7, Chapter 7, Sec. 3, "Procedures for Abatement of Highway Traffic Noise and Construction Noise," May 14, 1976.

68. U.S. Department of Housing and Urban Development, Aircraft Noise Impact-Planning Guidelines for Local Agencies, Report No. TE/NA-472, November 1972.

69. Bolt Beranek and Newman, Inc., "Calculation of Day-Night Levels (Ldn) Resulting from Civil Aircraft Operations," Report NO. 3157, prepared for the U.S. Environmental Protection Agency, March 1976.

70. U.S. Environmental Protection Agency, Background Document/Environmental Explanation for Proposed Interstate Rail Carrier Noise Emission Regulations, EPA 550/9-74-005a, June 1974.

71. Swing, Jack W., "Simplified Procedure for Developing Railroad Noise Exposure Contours," Sound and Vibration, February 1975.

72. __________, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, March 1974.

73. Federal Aviation Administration, "Developing Noise Exposure Controus for General Aviation Airports," December 1975.

74. U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, March 1974.

75. Bolt Beranek and Newman, Inc., "Design Guide for Highway Noise Prediction and Control, Report No. 2739, November 1974.

76. Bishop, D., *Program for the Measurement of Environmental Noise*, DOT-TST-74-4, U.S. Department of Transportation, September 1973.

77. Schwartz, J.M.; Yost, W.A.; and Green, A.E.S., "Community Noise Effort in Gainesville, Florida," *Sound and Vibration*, Vol. 8, No. 12, December 1974.

78. Bartel, C.; Sutherland, L.C.; and Simpson, L., *Airport Noise Reduction Forecast - Vol. I: Summary Forecast for 23 Airports*, DOT-TST-75-3, U.S. Department of Transportation, October 1974.

79. Federal Aviation Administration, "Developing Noise Exposure Contours for General Aviation Airports," December, 1975.

80. Gordon, C.G.; Galloway, W.J.; Kugler, B.A.; and Nelson, D.L., *Highway Noise - A Design for Highway Engineers*, National Cooperative Highway Research Program Report 117, 1971.

81. U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Highway Noise Impact Assessment Manual*, (forthcoming).

82. Galloway, W.J.; Eldred, K. and Simpson, M., *Population Distribution of the United States as a Function of Outdoor Noise Level*, EPA, 550/9-74-009, June 1974.

83. Safeer, H.B., *Airport Noise Exposure Noise Prediction*, DOT-TSC-FHWA-72-1, U.S. Department of Transportation, August 1972.

84. Bartel, C.; Coughlin, C.; Moran, J. and Watkins, L., *Airport Noise Reduction Forecast - Vol. II: NEF Computer Program Description and User's Manual*, DOT-TST-75-4, U.S. Department of Transportation, August 1974.

85. Nelson, K.E., and Wolsko, T.D., *Transportation Noise - Impacts and Analysis Techniques*, ANL/ES-27, Argonne National Laboratory, October 1973.

86. Wesler, J.E., *Manual for Highway Noise Prediction*, DOT-TSC-FHWA-72-1, U.S. Department of Transportation, March 1972.

87. MacDonald, Joseph A., "Will Solid Waste Bury Us?" *The Need for a National Materials Policy*, Part 2, U.S. Congress, 93rd, 2nd, Senate, Committee on Public Works, Hearings, July 17 and 18, 1974.

88. The management of solid wastes, as regulated by the U.S. Environmental Protection Agency, applies to: beverage containers; materials recovery source separation; the storage and collection of residential, commercial and institutional solid wastes; solid waste disposal programs, in terms of thermal processing; and acceptance of certain substances and recommended storage procedures for pesticides and containers, as found in 40 CFR 240-247.

89. Sanitary Engineering Research Laboratory, Comprehensive Studies of Solid Wastes Management, University of California, Berkeley, California, May 1972.

90. Berry, Brian J.L., et.al., Land Use, Urban Form and Environmental Quality, Department of Geography Research Paper No. 155, University of Chicago, 1974.

91. U.S. Environmental Protection Agency, Resource Recovery and Waste Reduction, Third Report to Congress, 1975.

92. Bartolotta, Robert J., "Local Government Solid Waste Programs," Yearbook - 1975, International City Management Association, Washington, D.C., 1975.

93. Comptroller General of the U.S., "Demonstration Grant Program Has Limited Impact on National Solid Waste Disposal Problem," The Need for a National Materials Policy, U.S. Congress, 93rd, 2nd, Senate, Committee on Public Works, Hearings, July 17 and 18, 1974.

94. Comptroller General of the United States, "Using Solid Waste to Conserve Resources and to Create Energy, Report to the Congress," Waste Control Act of 1975, U.S. Congress, 94th, 1st, House, Subcommittee on Transportation and Commerce of the Committee on Interstate and Foreign Commerce, Hearings, 1975.

95. Recommended Standards for Sanitary Landfall Design, Construction, and Evaluation & Model Sanitary Landfall Operation Agreement, U.S. Environmental Protection Agency, Washington, D.C., 1971.

96. Caffrey, Patrick; David, Martin; and Ham, Robert K., "Evaluation of Environmental Impact of Landfills," Journal of the Environmental Engineering Division, ASCE, Vol. 101, No. EEI, Proceedings Paper 11119, February 1975.

97. Darnell, Rezneat, Impacts of Construction Activities in Wetlands of the United States, U.S. Environmental Protection Agency Report 600/3-76-045, April 1976.

98. Thurow, Charles; Toner, William; and Erley, Duncan, "Wetlands," Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators, U.S. Environmental Protection Agency Report 600/5-75-005, March 1975.

99. Lee, Thomas M.. "Wisconsin's Shoreland Management Program," Journal of the Urban Planning and Development Division, ASCE, Vol. 98, No. UPI, Proceeding Paper 9054, July 1972.

100. Proceedings: Wetland Conference, Report No. 21, Institute of Water Resources, University of Connecticut, December 1973.

101. U.S. Environmental Protection Agency, "Protection of Nation's Wetlands: Policy Statement," 84 FR 10834, May 2, 1973.

102. 33 CFR 209.

103. Corps of Engineers, "Permits for Activities in Navigable Waters or Ocean Waters," 40 CFR 230.

104. Section 404, PL 92-500.

105. Crowley, David A., *et.al.*, *Wetlands, Related Legislation in the United States*, University of Miami Sea Grant Institute Program Report, University of Miami, Miami, Florida, 1974.

106. The reader who desired further information on the specific impacts of wetland development as borne by flora, fauna and the general ecology should refer to: *Freshwater Biology and Pollution Ecology*, EPA 430/1-75-005, U.S. Environmental Protection Agency, Office of Water Program Operations, Cincinnati, Ohio, 1975; Ketchum, Bostwick, ed., *The Water's Edge*, MIT Press, Cambridge, Massachusetts 1972; and Mathews *et.al.*, *Man's Impact on Terrestrial and Oceanic Ecosystems*, MIT Press, Cambridge, Massachusetts, 1972.

107. For example, Maines' Wetlands Act, Chapter 348 PL 1967, protects the ecology of areas bordering coastal waters; Massachusetts' G.L. c. 130 regulates the removal, filling, and dredging of areas bordering on coastal waters; Delaware's Coastal Zone Act (Title 7, Chapter 70) seeks to prohibit entirely the construction of new heavy industry in its coastal areas; Wisconsin's Shoreland Management Program enables counties to control the use of shoreland, defined as a specific distance from the edge of the water.

108. Estuarine Areas Act of 1968, 16 U.S.C. 1221.

109. Coastal Zone Management Act of 1972, 16 U.S.C. 1451-1464.

110. Section 302(h) of Coastal Zone Management Act of 1972.

111. Section 305 of Coastal Zone Management Act of 1972.

112. Section 306(d) of Coastal Zone Management Act of 1972.

113. Section 307 of Coastal Zone Management Act of 1972.

114. Knecht, R.W., and Agee, J.L., "OCZM/EPA Water Programs Coordination Principles," signed August 26, 1975, Washington, D.C.

115. Pisano, Mark, "Coordination of EPA Water Programs and Coastal Zone Management Programs," Program Guidance Memorandum AM-11, U.S. Environmental Protection Agency, Washington, D.C., September 29, 1975.

116. Meyers, Sheldon, "Guidance for EPA Participation in the Development and Review of State Coastal Zone Management Programs (CZMP's)," U.S. Environmental Protection Agency, June 24, 1975.

117. Cahill, Harold P., Pisano, Mark A., "Coordination of EPA Water Programs and Coastal Zone Management Programs," U.S. Environmental Protection Agency, September 15, 1975.

118. Office of General Counsel, "EPA Protection in State Coastal Zone Management Plan Development and Implementation," U.S. Environmental Protection Agency, November 25, 1975.

119. Ludwigson, John O., "Coastal Zone Management, A Whole New Ball Game," Monograph No. 18, Environment Reporter, BNA, Washington, D.C., March 8, 1974.

120. Section 307(c)(3) of Coastal Zone Management Act of 1972.

121. Flood Disaster Protection Act of 1973, PL 93-234, 87 Stat. 975, Sec. 1370.

122. Leopold, Luna B., Hydrology for Urban Land Planning - A Guidebook on the Hydrologic Effects of Urban Land Use, U.S. Geological Survey Circular 554, U.S. Department of Interior, Washington, D.C., 1968.

123. Congressional Research Service, "National Hazards," Congress and the Nation's Environment, U.S. Congress, 94th, 1st, Senate, Committee on Interior and Insular Affairs, April 1975.

124. Cahill, Harold P., and Greene, Alexander J., "Flood Disaster Protection Act of 1973," Program Guidance Memorandum No. PG.-25, U.S. Environmental Protection Agency.

125. Cahill, Harold P., "Supplement to PG No. 25; Flood Disaster Protection Act of 1973 (PL 93-234)," Program Guidance Memorandum PG-25A, U.S. Environmental Protection Agency, November 4, 1974.

126. Alm, Alvin, "Flood Insurance Requirements Effective July 1, 1975," Program Guidance Memorandum PG-54, U.S. Environmental Protection Agency, July 8, 1975.

127. 24 CFR 1914.

128. Federal Insurance Administration, " National Flood Insurance Program," Title 24, Chapter X, Subchapter B, Section 1909-1915, U.S. Department of Housing and Urban Development.

129. The Fish and Wildlife Coordination Act, PL 85-624.

130. The Endangered Species Conservation Act, 16 U.S.C. 668aa to 668cc-6.

131. Allen, Durward L., "The Preservation of Endangered Habitats and Vertebrates of North America," Future Environments of North America, edited by Darling, F. Fraser, and Milton, John P., Natural History Press, Garden City, New York, 1966.

132. Wildlife in an Urbanizing Environment, Cooperative Extension Service, University of Massachusetts, Amherst, Massachusetts, 1974.

133. Bureau of Sport Fisheries and Wildlife, "Threatened Wildlife of the U.S.," U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

134. Land and Water Conservation Fund Act of 1965, 16 U.S.C. 460-4 to 460-11.

135. Adams, Robert L.; Lewis, Robert C.; and Drake, Bruce H., *Outdoor Recreation, A Legacy for America, Appendix A, An Economic Analysis*, U.S. Department of Interior, Bureau of Outdoor Recreation, December 1975.

136. Clawson, Marion, "Methods of Measuring the Demand for and Value of Outdoor Recreation," Reprint Number 10, Resources for the Future, Inc., Washington, D.C., 1972.

137. Wilkinson, Paul F., "The Use of Models in Predicting the Consumption of Outdoor Recreation," *Journal of Leisure Research*, Vol. 5, No. 3, Summer 1973.

138. Hammon, Gordon A., *et.al.*, *Capacity of Water Based Recreation Systems, Part I: The State of the Art--A Literature Review*, Report No. 90, Water Resources Research Institute, University of North Carolina, Raleigh, North Carolina, April 1974.

139. Land and Water Conservation Fund Act, 16 U.S.C. 4601-4 to 4601-11.

140. Wild and Scenic Rivers Act, 16 U.S.C. 1271-1287.

141. Bureau of Outdoor Recreation and National Park Service, *Guidelines for Evaluating Wild, Scenic, and Recreational River Areas Proposed for Inclusion in the National Wild and Scenic Rivers System Under Section 2, PL 90-542* Document No. 888-490, U.S. Department of Interior and U.S. Department of Agriculture, February 1970.

142. Wild and Scenic Rivers Act, 16 U.S.C. 1273 (b)(1).

143. Wild and Scenic Rivers Act, 16 U.S.C. 1273 (b)(2).

144. Wild and Scenic Rivers Act, 16 U.S.C. 1273 (b)(3).

145. Wild and Scenic Rivers Act, 16 U.S.C. 1278.

146. Kaiser, Edward J., *et.al.*, *Promoting Environmental Quality Through Urban Planning and Controls*, U.S. Environmental Protection Agency Report 600/5-73-015, February 1974.

147. The National Environmental Policy Act of 1969, PL 91-190, Sec. 101(b)(4).

148. The National Historic Preservation Act of 1966, PL 89-655; the Archaeological and Historic Preservation Act of 1974, PL 93-291; "Protection and Enhancement of the Cultural Environment," Executive Order 11593, May 13, 1971; Additional Acts pertaining to the subject area are The Antiquities Act of 1906, PL 59-209, and the Historic Sites Act of 1935, PL 74-292.

149. Advisory Council on Historic Preservation, "Procedures for Protection of Historic and Cultural Properties," 36 CFR Part 800.

150. Council on Environmental Quality, "Guidelines for the Preparation of Environmental Impact Statements," 40 CFR 1500.

151. Rhett, John T. and Meyers, Sheldon, "Field Surveys to Identify Cultural Resources Affected by EPA Construction Grants Projects," Program Guidance Memo #52, U.S. Environmental Protection Agency, July 2, 1975.

152. Opinion of Allen Olson, EPA Legal Assistant.

153. Gutheim, Frederick, "Preface," Continuity and Change, Papageorgiou, Alexander, Praeger Publishers, New York.

154. Advisory Council on Historic Preservation, "Suggested Guidelines for State Historic Preservation Legislation," Historic Preservation Workshop, National Symposium on State Environmental Legislation, Washington, D.C., March 1972.

155. Office of Archaeological and Historic Preservation, National Register of Historic Places, U.S. Department of Interior, National Park Service, Washington, D.C.

156. Guidelines for Compliance with NEPA in the Title II Wastewater Treatment Works Construction Grants Program and the Areawide Waste Treatment Management Planning Program, 40 CFR 6.510, Criteria for Preparation of Environmental Impact Statements.

157. Anderson, William D., Gustafson, Gregory C., and Boxley, Robert F., "Perspectives on Agricultural Land Policy," Journal of Soil and Water Conservation, 31:1, January-February, 1975.

158. Frey, H. Thomas, Major Uses of Land in the United States: Summary for 1969, Agricultural Economic Report No. 247, U.S. Department of Agriculture, 1973.

159. Holt, James S., "Problems of Increasing Farm Real Estate Values," Farm Economics, Cooperative Extension Service, The Pennsylvania State University, July 1975.

160. Roup, Philip M., "Urban Threats to Rural Lands: Background and Beginnings," AIP Journal, November 1975.

161. Farm Corporations -- A Financial Analysis, Agricultural Economic Report No. 241, U.S. Department of Agriculture, Economic Research Service, July 1973.

162. 1973 Handbook of Agricultural Charts, Agricultural Handbook No. 455, U.S. Department of Agriculture, Economics Research Service, October 1973.

163. Rural Zoning in the United States: Analysis of Enabling Legislation, Miscellaneous Publication No. 1232, U.S. Department of Agriculture, Economic Research Service, July 1972.

164. State Programs for the Differential Assessment of Farm Space and Open Land, Agricultural Economic Report No. 256, U.S. Department of Agriculture, Economic Research Service, April 1974.

165. Gustafson, Gregory C., and Wallace, L.T., "Differential Assessment as Land Use Policy: The California Case," AIP Journal, 41:6, November 1975.

166. Gryant, William R., and Conklin, Howard E., "New Farmland Preservation Programs in New York," AIP Journal, 41:6, November 1975.

167. McBride, George, and Clawson, Marion, "Negotiation and Land Conversion," AIP Journal, January 1970.

168. Costonis, John J., "Development Rights Transfer: Description and Perspective for a Critique," Management & Control of Growth, Vol. III, Scott, Randall, W., ed., The Urban Land Institute, Washington, D.C., 1975.

169. Smith, Clyn, "Easements to Preserve Open Space Land," Ecology Law Quarterly, 1:4, Fall 1971.

170. Cook, Earl, "Statement of Earl Cook," The Impact of Growth on the Environment, U.S. Congress, 93rd, 1st, Senate, Subcommittee on Air and Water Pollution, Committee on Public Works, Hearings, April 2 and 3, 1973.

171. Darmstadter, Joel, "Energy Consumption: Trends and Patterns," Economic Growth and the Environment," Schurr, Sam H., ed., Resources for the Future, Johns Hopkins Press, Baltimore, 1972.

172. Cook, Earl, "The Flow of Energy in an Industrial Society," Scientific American, 24:3, September 1971.

173. Patterns of Energy Consumption in the United States, Stanford Research Institute, Menlo Park, California, 1971.

174. Real Estate Research Corporation, The Costs of Sprawl, prepared for CEQ, HUD, and EPA, U.S. Government Printing Office, Washington, D.C., April 1974.

175. Roberts, James S., "Energy and Land Use: Analysis of Alternative Development Patterns," Environmental Comments, September 1975.

176. Milgram, Grace, The City Expands, A Study of the Conversion of Land From Rural to Urban Use, University of Pennsylania, Philadelphia, Pennsylvania, March 1967.

BIBLIOGRAPHY OF NONCITED SOURCES

Chapter 1 - General

1. Abt Associates, *The Social Impact of Having Clean Water*, prepared for National Commission on Water Quality, June 9, 1975.
2. *Environmental Quality* - 1975, Council on Environmental Quality, December 1975.
3. *Summary Analysis - Public Response to the Proposed Principles & Standards*, U.S. Water Resources Council, July 1972.
4. U.S. Water Resources Council, "Water and Related Land Resources - Establishment of Principles and Standards for Planning," 38 FR 24778, September 10, 1973.

Chapter 2 - Growth and Secondary Impact Assessment

1. *A Guide to Models in Governmental Planning and Operations*, U.S. Environmental Protection Agency Report 600/5-74-008, August 1974.
2. Appelbaum, Richard P., *et.al.*, *The Effects of Urban Growth, A Population Impact Analysis*, Praeger Press, New York, New York, 1976.
3. Beale, Calvin L., "The Revival of Population Growth in Nonmetropolitan America," ERS-605, U.S. Department of Agriculture, Economic Research Service, June 1975.
4. Cockfield, Richard W., and Handa, Virginia K., "Design Concept for Assigning Urban Space, *Journal of the Urban Planning and Development Division*, ASCE, Vol. 97, No. UP2, Proc. Paper 8582, December 1971.
5. Feldt, Allan G., *CLUG: Community Land Use Game*, The Free Press, New York, 1972.
6. Greenberg, Michael R.; Krueckeberg, Donald A.; and Mautner, Richard, *Long-Range Projections for Minor Civil Divisions: Computer Programs and User's Manual*, Rutgers University, New Brunswick, New Jersey, May 1973.
7. Greenwood, Michael J., "Research on Internal Migration in the United States: A Survey," *The Journal of Economic Literature*, Vol. 13, No. 2, June 1975.
8. Hansen, Kristin A., *et.al.*, "Mobility of the Population of the United States, March 1970 to March 1975," *Current Population Reports*, U.S. Bureau of the Census, Series P-20, No. 285, 1975.
9. *Industrial Location Policy*, 3 parts, U.S. Congress, 91st, 2nd, House Ad Hoc Subcommittee on Urban Growth, Committee on Banking and Currency, Hearings, July through December 1970.

10. "Influx of Population Down in Urban Areas," New York Times, June 16, 1975.

11. Kaiser, Edward J., et.al., Promoting Environmental Quality Through Urban Planning and Controls, U.S. Environmental Protection Agency Report 600/5-73-015, February 1974.

12. McPherson, M.B., Prospects for Metropolitan Water Management, ASCE, December 1970.

13. McPherson, M.B., Regional Earth Science Information in Local Water Management, ASCE, July 1975.

14. Manual on Urban Planning, ASCE, New York, 1967.

15. Marks, David H., ReVelle, Charles S., and Liebman, Jon C., "Mathematical Models of Location: A Review," Journal of the Urban Planning and Development Division, ASCE Vol. 96, No. UP1, Proc. Paper 7164, March, 1970.

16. Moore, Will Terry; Ridel, Fredric J.; and Rodriquez, Carlos G., An Introduction to Urban Development Models and Guidelines for Their Use, U.S. Department of Transportation, Federal Highway Administration, January 1975.

17. Morrison, Peter A., "The Current Demographic Context of National Growth and Development," The Rand Paper Series, Santa Monica, California, September 1975.

18. National Academy of Sciences, Land Use and Transportation Planning, Highway Research Board, No. 422, 1973.

19. National Growth and Development, Second Biennial Report to Congress, prepared under direction of The Committee on Community Development, The Domestic Council, December 1974.

20. Readings on Land Use Policy, U.S. Congress, 94th, 1st, Senate, Committee on Interior and Insular Affairs, June 1975.

21. Riley, Russell H., "Basic Data - Sources and Utilization," Handbook on Urban Planning, Claire, William H., ed., Van Nostrand Reinhold, New York, 1973.

22. Seidman, David R., The Construction of An Urban Growth Model, Delaware Valley Regional Planning Commission, Philadelphia, (no date).

23. Task Force of Science Advisory Panel of the House Public Works Committee, A National Public Works Investment Policy, Committee Print 93-53, U.S. Congress, House, Committee on Public Works, December 1974.

24. "Significant Change Seen in Urban Growth Patterns," Engineering News Record, May 29, 1975.

25. Sweet, David C., ed., Models of Urban Structure, Lexington Books, Lexington, Massachusetts, 1972.

26. "The Exodus," The Wall Street Journal, June 5, 1975.

27. Urban Systems Research and Engineering, The Growth Shapers - Land Use Impacts of Intrastructure Investments, report prepared for Council on Environmental Quality, 1976.

28. U.S. Commission on Population Growth and the American Future, Population Distribution and Policy, Mazie, Sara Mills, ed., Vol. V of Commission research reports, 1972.

Chapter 3 - Media Impacts

1. Amy, Gary, et.al., Water Quality Management Planning for Urban Runoff, U.S. Environmental Protection Agency Report 440/9-75-004, December 1974.

2. Briggs, T.M.; Overstreet, M.; Kothari, A.; and Devitt, T.W., Air Pollution Considerations in Residential Planning, Volume I: Manual, U.S. Environmental Protection Agency Report 450/3-74-046a, July 1974.

3. Committee on Ecological Research, The Role of Ecology in the Federal Government, Council on Environmental Quality, December 1974.

4. Commission on Natural Resources, et.al., Air Quality and Stationary Source Emission Control, U.S. Congress, 94th, 1st, Senate, Committee on Public Works, March 1975.

5. Congressional Research Service, A Legislative History of the Noise Control Act of 1972, U.S. Congress, 93rd, 2nd, Senate, Committee on Public Works, July 1974.

6. Decision-Makers Guide in Solid Waste Management, Guide SW-500, U.S. Environmental Protection Agency, 1976.

7. Epstein, A.H., et.al., A Guide for Considering Air Quality in Urban Planning, U.S. Environmental Protection Report 450/3-74-020, March 1974.

8. Hagevik, George, ed., The Relationship of Land Use and Transportation Planning to Air Quality Management, Rutgers University, New Brunswick, New Jersey, May 1972.

9. Hydrology Committee, Essentials of Ground-Water Hydrology Pertinent to Water-Resource Planning, U.S. Water Resources Council, August 1973.

10. Implementation of the Clean Air Act - 1975, U.S. Congress, 94th, 1st, Senate, Subcommittee on Environmental Pollution, Committee on Public Works, Hearings, March 19,20, and April 21, 22, 23, 1975.

11. Implementation of the Federal Water Pollution Control Act, U.S. Congress, 93rd, 2nd, House, Subcommittee on Investigations and Review, Committee on Public Works, Hearings, February, April, June, and July, 1974.

12. Institute of Public Administration, et.al., Evaluating Transportation Controls to Reduce Motor Vehicle Emissions in Major Metropolitan Areas, U.S. Environmental Protection Agency Report APTD - 1365, November 1972.

13. Nondegradation Policy of the Clean Air Act, U.S. Congress, 93rd, 1st, Senate, Subcommittee on Air and Water Pollution, Committee on Public Works, Hearings, July 24, 1973.

14. U.S. Environmental Protection Agency, Non-Point Source Control, U.S. Congress, 93rd, 1st, Senate, Committee on Public Works, Hearings, March 1973.

15. __________, Stormwater Management Model, Vols. I-IV, 1971.

16. "Water and Related Land Resources Planning," U.S. Water Resources Council, June 22, 1970.

Chapter 4 - Sensitive Environmental Areas

1. Baker, John A., Wetland and Water Supply, Geological Survey Circular 431, U.S. Department of Interior, 1960.

2. Burton, Ian, Types of Agricultural Occupance of Flood Plains in the United States, Department of Geography, Research Paper No. 75, University of Chicago, 1962.

3. "Flood Plains: No Longer Up For Grabs?" Conservation Foundation Letter, May, 1975.

4. Gannon, Joseph W., "Constitutional Implications of Wetland Legislation," Environmental Affairs, Vol. 1, No. 3, November, 1971.

5. Guidelines for Determining Flood Flow Frequency, U.S. Water Resources Council, 1976.

6. Institute of Rural Environmental Health, A Study of Mosquito Prevention and Control Problems Associated with Stream Modification Projects, U.S. Water Resources Council, 1974.

7. Lewis, Sylvia, "Coastal Plan Runs Aground," Planning, ASPO, November, 1975.

8. O'Toole, Denis, "Analysis of the National Flood Insurance Program," Environmental Comment, November, 1974.

9. Pope, R.M., and Gosselink, James G., "A Tool for Use in Making Land Management Decisions Involving Tidal Marshland," Coastal Zone Management Journal, Vol. 1, No. 1, Fall 1973.

10. Regulation of Flood Hazard Areas to Reduce Flood Losses, (2 Vols.), U.S. Water Resources Council, 1972.

11. *Restrictions: Conservation Inland Wetlands, Coastal Wetlands*, Massachusetts Audubon Society, 1973.

12. Spencer, James, *Review of Dredge and Spoil Disposal Practices in Massachusetts*, Massachusetts Coastal Zone Management Office, December, 1975.

Chapter 5 - Unique Areas

1. Bishop, A.B., *et.al.*, Carrying Capacity in Regional Environmental Management, U.S. Environmental Protection Agency, Report 600/5-74-021, February, 1974.

2. Corps of Engineers, "Cultural Resources: Identification and Administration; Policies and Procedures," U.S. Department of Defense, 40 FR 4136, September 8, 1975.

3. "Guideline. Review and Comment of the Water Resources Council on Wild and Scenic Rivers Proposals of the Department of Agriculture and the Department of Interior," U.S. Water Resources Council, 1971.

4. "Historic Preservation," *Urban Land*, July/August, 1975.

5. "Recycling Buildings to New Uses Brings Revenue from Recession," *Engineering News Record*, July 31, 1975.

6. Mann, Lawrence D., "Open Space Accessibility for Recreation," *Journal of the Urban Planning and Development Division*, ASCE, Vol. 97, No. UP2, Proc. Paper 8607, December, 1971.

7. Rutledge, Albert J., *Anatomy of a Park*, McGraw-Hill, New York, 1971.

8. Stankey, George, and Lime, David, *Recreational Carrying Capacity: An Annotated Bibliography*, General Technical Report INT-3, U.S. Department of Agriculture, Forest Service, March, 1973.

9. Stam, Jerome, M. and Courtney, Eleanor L., *Farm Real Estate Taxes, Recent Trends and Developments*, RET-14, U.S. Department of Agriculture, Economic Research Service, March, 1975.

10. Stankey, George, and Lime, David, *Recreational Carrying Capacity: An Annotated Bibliography*, General Technical Report INT-3, U.S. Department of Agriculture, Forest Service, March, 1973.

11. Wright, Russell, *Techniques for Incorporating Historic Preservation Objectives into the Highway Planning Process*, prepared for the U.S. Department of Transportation, April, 1974.

Chapter 6 - Economic Impacts

1. "Agricultural Price Standards," U.S. Water Resources Council, October, 1974.

2. Berkowitz, David A., and Squires, Arthur M., ed., *Power Generation and Environmental Change*, Cambridge: MIT Press, 1971.

3. *Growth and Its Implications for the Future*, (4 parts), 93rd Congress, House Subcommittee on Fisheries and Wildlife Conservation and the Environment, Committee on Merchant Marine and Fisheries, Hearings, May, 1973, June and November, 1974.

4. Hayes, Denis, *Energy: The Case for Conservation*, Worldwatch Paper 4, Washington, D.C., January, 1976.

5. *OBERS Projections (Series E), Incremental Projections and Ratios of Future (1985 and 2000) to Current (1975) Population, Personal Income and Earnings Aggregated Subareas*, U.S. Water Resources Council, June, 1975.

6. Soil Conservation Service, *Perspectives on Prime Lands*, U.S. Department of Agriculture, 1975.

7. Pimentel, David, *et*.*al*., "Energy and Land Constraints in Food Protein Production," *Science*, November 21, 1975.

8. *Water for Energy Self-Sufficiency*, U.S. Water Resources Council, October, 1974; Water Resources Center, Proceedings of the Workshop on Research Needs Related to Water for Energy, Research Report No. 93, University of Illinois at Urbana-Champaign, November, 1974.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1978 720-335/6054